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THE EDUCATION AND EMPLOYMENT OF TECHNICIANS. INTERIM REPORT.
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THE TECHNICAL MANPOWER CONFERENCE, HELD AT THE PENNSYLVANIA STATE UNIVERSITY CAMPUS ON JANUARY 24 AND 25, 1968, WAS THE FIRST PHASE IN THE DISSEMINATION OF THE RESEARCH PROJECT, "EFFECTS OF FIELD AND JOB ORIENTED TECHNICAL RETRAINING ON MANPOWER UTILIZATION OF THE UNEMPLOYED." THE PRESENTATIONS IN PART I, INTENDED TO PROVIDE BACKGROUND AND GENERAL CONSIDERATIONS CONCERNING THE EDUCATION AND INDUSTRIAL UTILIZATION OF TECHNICIANS, ARE--(1) "THE EDUCATION AND UTILIZATION OF TECHNICIANS" BY F.A. GREGORY, (2) "DEVELOPING TECHNICAL MANPOWER, THE ROLE OF INDUSTRY" BY F.R. THORNTON, (3) "DEVELOPING TECHNICAL MANPOWER, THE ROLE OF EDUCATION" BY R.M. KNOEBEL, AND (4) "TECHNICAL MANPOWER AND INDUSTRIAL DEVELOPMENT" BY T.R. ROBB. THE PRESENTATIONS IN PART II, CONCERNED WITH AN EFFORT TO ANSWER SPECIFIC QUESTIONS ABOUT THE EDUCATION AND EMPLOYMENT OF MECHANICAL TECHNICIANS, ARE--(1) "FIELD-ORIENTED TECHNICIAN EDUCATION" BY W.A. DUNN, (2) "JOB-ORIENTED TECHNICAL EDUCATION" BY G.W. ELISON, (3) "MANPOWER RESEARCH, IMPLICATIONS FOR THE EDUCATION OF TECHNICIANS" BY C.R. FINCH, AND (4) "THE DESIGN GRADUATE AND HIS JOB" BY S.R. WIERSTEINER. (HC)

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THE EDUCATION AND EMPLOYMENT OF TECHNICIANS

INTERIM REPORT

Project No. 5-0085
Contract No. 4-10-108

Edited by DAVID C. BJORKQUIST

VOCATIONAL – INDUSTRIAL EDUCATION **Research Report**

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
Office of Education · Bureau of Research

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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Interim Report
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THE EDUCATION AND EMPLOYMENT OF TECHNICIANS

Edited By

David C. Bjorkquist

DEPARTMENT OF VOCATIONAL EDUCATION
THE PENNSYLVANIA STATE UNIVERSITY
UNIVERSITY PARK, PENNSYLVANIA
MARCH, 1968

The research reported herein was performed pursuant to a contract with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U. S. Department of
Health, Education, and Welfare
Office of Education
Bureau of Research

FOREWORD

A major step in the dissemination of the research project, Effects of Field and Job Oriented Technical Retraining on Manpower Utilization of the Unemployed, is reported in this record of proceedings of the final conference held at The Pennsylvania State University, University Park, on January 24 and 25, 1968. The conference was jointly sponsored by the University and the U. S. Office of Education. Dr. David C. Bjorkquist, Director of the Project, and Mr. Curtis R. Finch and Mr. S. R. Wiersteiner, Research Assistants, conducted the conference as part of the dissemination plan of the research of U. S. Office of Education Project No. 5-0085.

The research reported in these pages and the conference presentations and discussions about it are aspects of the continuing research program of the Department of Vocational Education at Penn State. Additional orientation to the research project may be found in periodic progress reports of the Director and in two movies which were produced, "The Retreads," and "Upgrade."

Generally, we are enthusiastic and optimistic that the research makes a new focus for the education of technicians -- flexibility in curriculum and length of the educational program. The importance of technically trained manpower to the nation's economy, and the democratic value of educational opportunity to our citizens suggest that flexibility of program, particularly for retraining purposes, becomes predominant.

The conference and this report were made possible by cooperation on the parts of numerous persons: the Research Director and his staff, keynote speakers, discussion leaders, participants, and the conference staff of the Continuation Center. For all of these efforts and interest, the Department of Vocational Education is indebted.

George L. Brandon, Head
Department of Vocational Education

INTRODUCTION

As the products and processes of American industry have become more complex, so have the demands made of industrial workers. In some cases the worker has become more specialized, while in others his job has required him to operate in more than one arena. The quest for better ways of producing goods and services has resulted in a juggling of job duties and the recognition of at least one new category of workers--technicians.

Like the craftsman and the professional, who bracket him, the technician suffers from lack of precise definition. There is great variance in his job duties, even within a single occupational group, and differences about the philosophy of his preparation.

Early in 1964, a research project was initiated in the Department of Vocational Education of The Pennsylvania State University to study two approaches to the education of technicians. The research in this project, Effects of Field and Job Oriented Technical Retraining on Manpower Utilization of the Unemployed, was of two specially designed training programs operated under the provisions of the Manpower Development and Training Act. A job-oriented program was conducted by the School District of the City of Allentown and a field-oriented program was conducted on the University's Altoona Campus by the College of Engineering. The Technical Manpower Conference which was held on the University Park campus of the University on January 24 and 25, 1968 was one phase of the dissemination of this research project and provided the substance of this monograph.

The monograph itself is divided into two parts. Part I is intended to provide some background and general considerations concerning the education and industrial utilization of technicians. Mr. Francis A. Gregory provides a baseline for consideration of the employment and education of technicians in the first presentation. This is followed by a discussion of what industry is doing and can do to more fully utilize technicians and assist in their preparation, by Dr. Fred R. Thornton. Mr. Robert M. Knoebel's presentation deals with the role of education in developing technical manpower. The concluding presentation in Part I is by Mr. Theodore R. Robb and is concerned with the relationship of technical manpower to industrial development and economic growth.

Part II of this monograph contains four presentations concerned with an effort to answer some specific questions about the education and employment of mechanical technicians. The job and field oriented training research project serves as the basis for these presentations. Mr. William A. Dunn and Mr. George W. Elison, respectively, discuss their philosophies of field and job oriented technical education in the first two presentations. The third presentation is by Mr. Curtis R. Finch about the job and field oriented training research and its implications for the education of technicians. The final presentation, about the same research and its implication for the employment of technicians, is by Mr. S. R. Wiersteiner.

Although a report of a conference, such as this, suggests finality or conclusion, it is our hope that this exchange of ideas will be only one step in a continuing dialogue about the education and employment of technicians.

David C. Bjorkquist
Editor and Project Director

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PART I

THE EDUCATION AND UTILIZATION OF TECHNICIANS

Francis A. Gregory, Associate Director,
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U. S. Department of Labor
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It is a pleasure to participate in this Technical Manpower Conference sponsored by The Pennsylvania State University. This respected institution has made a substantial and sustained contribution to the search for answers to the problems of the development of manpower of such quantity, quality, and mix as to assure the security and productivity of the Nation. The last survey by the Engineering Manpower Commission of Engineers Joint Council (Engineering Manpower Commission, 1967, p. 14) shows that in the academic year 1965-66 Penn State was offering ECPD accredited courses in engineering technology in fourteen centers around the state. The current count may be higher.

The University's four-year research project on technician training, which is being discussed today, is another example and is of particular interest to the Manpower Administration of the Department of Labor because of the new knowledge it will yield on approaches to effective and efficient preparation of this classification of worker. Regarding research in this field, we are probably at the point of testing hypotheses and defining terms for a phenomenon just about as changeless as an exploding nebula. In terms of its mission, the Department of Labor's prime concern is with the present and projected supply and demand of technicians, and the effect of their presence in the labor force, in various patterns of utilization, on the economy of the United States.

Our monitoring and research commitment on this aspect of the problem is a continuing one. We have some involvement with the development of technician manpower, largely from the ranks of the unemployed and the underemployed, through the provisions and resources of the Manpower Development and Training Act and related legislation, which we administer in cooperation with the Department of Health, Education and Welfare. We would say quickly that the major opportunity for direct research and experimentation on the preparation and utilization of the technician rests with the preparers and the utilizers, that is to say with educational institutions and industry in both the public and private sectors. My comments today, which are intended to open up some of the questions to be dealt with in greater depth during the course of the conference, draw on the findings and thinking in such circles as those of universities and other educational institutions, professional societies, industry, research organizations and government.

The Role of the Technician

It would seem appropriate first to attempt to identify the technician in the ranks of industry's workers. Efforts at a definition may be fogged by differences in the point from which the technician is observed, by certain oscillations in his accommodation in the industrial mechanism, and a definite excursion upward as the total knowledge of science and its applications expands. However, some agreements are being reached on the nature of the technician and even on the suborders of the species, circa 1968. It is certainly unnecessary to dwell on definitions with a group, such as this, which has daily involvement in either the preparation or utilization of technicians. Also, undue concentration on the semantics of a rigorous definition of a still evolving concept may be frustrating. Nevertheless some recapitulation of current understandings may be useful.

If we ignore the looser and less favored, although not infrequent, use of the term technician to identify certain routine jobs with a narrow skill range, then geographically, technician occupations lie somewhere north of the so-called skilled occupations and south of the professions. They can either be related to professional activities in helping roles or to the production aspects of an enterprise or industry in planning or supervisory functions, or exist in relative independence as in the case of some surveyors and technical salesmen. Technicians can, in effect, multiply the capacity of the professional by relieving him of more routine duties. Looking in the other direction they can increase the efficiency of the production end of an industry by introducing quantity and quality control influences that may not have been previously present in the system. They are found across the broad range of industry in the physical, biological and behavioral sciences and their respective fields of application. Although not yet attained, the following ratios (Criteria, 1966) indicate typical estimates of the relative need for technicians as support personnel: two for every engineer or physical scientist; from six to ten for every medical doctor or professional researcher in the health field; and from four to five for each biological or agricultural scientist.

It is recognized that the focus of this conference is on the engineering technician and particularly the mechanical technician among engineering technicians. May it be noted, then, that engineering technicians have their counterparts in helping roles in pure science research activities, employment offices, medical laboratories, hospitals, psychological clinics, and indeed wherever the goods and services of our economy are produced.

The options exist of identifying a given type of worker either in terms of 1) what he is capable of doing, 2) what he is called upon to do, or 3) the content of his preparation. Each approach has certain advantages and disadvantages. A combination of the three may give the clearest image of the engineering technician.

In reference to the first of these, the capabilities of the technician, there is probably at present no more rational and tested identification of the essential general abilities for success in technician occupations than those developed by the U. S. Office of Education (Occupational criteria, 1962, p. 5) based on studies of technical institute graduates, advisory committee recommendations, consultative services, and manpower study reports prepared by various government agencies including the Bureau of Labor Statistics and the Bureau of Employment Statistics of the U. S. Department of Labor, and the National Science Foundation. Five technical abilities were chosen as common requirements for technician occupations, following an analysis of the functions and responsibilities of the technician, including those of judgment and decision making. These five general abilities are:

1. Facility with mathematics; ability to use algebra and trigonometry as tools in the development of ideas that make use of scientific and engineering principles; an understanding of, though not necessarily facility with, higher mathematics through analytical geometry, calculus, and differential equations, according to the requirements of the technology.

2. Proficiency in the application of physical science principles, including the basic concepts and laws of physics and chemistry that are pertinent to the individual's field of technology.

3. An understanding of the materials and processes commonly used in the technology.

4. An extensive knowledge of a field of specialization with an understanding of the engineering and scientific activities that distinguish the technology of the field. The degree of competency and the depth of understanding should be sufficient to enable the individual to do such work as detail design using established design procedures.

5. Communication skills that include the ability to interpret, analyze, and transmit facts and ideas graphically, orally, and in writing.

Within the framework established by these five ability requirements the study was extended to the development of twelve criteria (Occupational criteria, 1962, pp. 6-8) for the identification of technician occupations. No single occupation would require all of them but anyone of them should be applied only within the limits of competence established by the five ability requirements. These twelve criteria offer, then, one means for identifying the technician in terms of the performance requirements of the job. The twelve criteria are:

1. Applies knowledge of science and mathematics extensively in rendering direct technical assistance to scientists or engineers engaged in scientific research and experimentation.

2. Designs, develops, or plans modifications of new products and processes under the supervision of engineering personnel in applied engineering research, design, and development.

3. Plans and inspects the installation of complex equipment and control systems.

4. Advises regarding the maintenance and repair of complex equipment with extensive control systems.

5. Plans production as a member of the management unit responsible for efficient use of manpower, materials, and machines in mass production.

6. Advises, plans, and estimates costs as a field representative of a manufacturer or distributor of technical equipment and/or products.

7. Is responsible for performance or environmental tests of mechanical, hydraulic, pneumatic, electrical, or electronic components or systems and the preparation of appropriate technical reports covering the tests.

8. Prepares or interprets engineering drawings and sketches.

9. Selects, compiles, and uses technical information from references such as engineering standards, handbooks, and technical digests of research findings.

10. Analyzes and interprets information obtained from precision measuring and recording instruments and makes evaluations upon which technical decisions are based.

11. Analyzes and diagnoses technical problems that involve independent decisions.

12. Deals with a variety of technical problems involving many factors and variables which require an understanding of several technical fields.

Definitions of Technician

The guidelines and procedures just described were developed by the Division of Vocational (and Technical) Education to supply the state and local levels with a systematic approach to the establishment, administration, supervision and operation of preparatory technician programs. The definition of the technician it provides is substantially in agreement with the less analytically stated description by the United States Employment Service in its Dictionary of Occupational Titles, (Dictionary, 1965) where the meaning of "technician" in general is given as:

> A term applied to a worker who works in direct support of ENGINEERS or SCIENTISTS, utilizing theoretical knowledge of fundamental scientific, engineering, mathematical, or draft design principles. Solves practical problems encountered in fields of specialization, such as those concerned with development of electrical and electronic circuits, and establishment of testing methods for electrical, electronic, electromechanical, and hydromechanical devices and mechanisms; application of engineering principles in solving design, development, and modification problems of parts or assemblies for products or systems; and application of natural and physical science principles to basic or applied research problems in fields, such as metallurgy, chemistry, and physics.

or the more popular language of the Bureau of Labor Statistics' Occupational Outlook Handbook. (Handbook, 1966)

> The term "technician," as used here, refers to technical workers whose jobs require both knowledge and use of scientific and mathematical theory; specialized education or training in some aspect of technology or science; and who, as a rule, work directly with scientists and engineers.
>
> In general, the jobs of engineering and science technicians are more limited than those of the engineer or scientists, and have a greater practical orientation. Many of these technician jobs require the ability to analyze and solve engineering and science problems and prepare formal reports on experiments, tests, or other projects. Some require considerable aptitude in mathematics; others, the ability to visualize objects and to make sketches and drawings. Design jobs often require creative ability. Many technician jobs require creative ability. Many technician jobs require some familiarity with one or more of the skilled trades, although not the ability to perform as a craftsman. Still others demand extensive knowledge of industrial machinery, tools, equipment, and processes. Some jobs held by these technicians are supervisory and require both technical knowledge and the ability to supervise people.
>
> In carrying out their assignments, engineering and science technicians frequently use complex electronic and mechanical instruments, experimental laboratory apparatus, and drafting instruments. Almost all of the technicians whose jobs are described in this statement must be able to use engineering handbooks and computing devices such as the slide rule or calculating machine.
>
> Technicians engage in virtually every aspect of engineering and scientific work. In research, development, and design work, one of the largest areas of employment, they conduct experiments or tests; set up, calibrate, and operate instruments; and make calculations. They also assist scientists and engineers in developing experimental equipment and models by making drawings and sketches and, under the engineer's direction, frequently do some design work.

> Technicians also work in jobs related to production, usually following a course laid out by the engineer or scientists, but often without close supervision. They may aid in the various phases of production operations, such as working out specifications for materials and methods of manufacture, devising tests to insure quality control of products, or making time-and-motion studies (timing and analyzing the workers movements) designed to improve the efficiency of a particular operation. They may also perform liaison work between engineering and production or other departments.
>
> Technicians often do work that might otherwise have to be done by engineers. They may serve as technical sales or field representatives of manufacturers; advise on installation and maintenance problems; or write specifications and technical manuals.

or the statement of Engineering Manpower Commission of Engineers Joint Council. (Engineering Manpower Commission, 1967, p. 3)

> In the technician, industry seeks an individual whose education includes enough scientific and theoretical background to enable him to appreciate why his activities are important and how they fit into the overall technological picture, and enough practical training to permit him to apply his knowledge quickly and efficiently to industrial problems. It is commonly said that the technician is an assistant to the engineer or scientist. However, he is more than an assistant. In many activities he is called upon to do things that engineers do not normally do, and he does many of them better than the average engineer could. The areas of detail design, drafting, test and inspection, maintenance, field service, and a host of others come to mind. Within the areas of his special expertise, the technician, on the basis of his education and experience, is frequently able to function in a limited, but effective, engineering capacity.

All of these specifications describe a worker with something more than average general ability; aptitude salients in mathematics, science and graphics; grasp of at least one field of technology; facility in communication; a knack for problem solving; and educational development certainly into the subprofessional band. All definitions would subtract the term "technician" from the title of occupations of narrower scope requiring lower levels of understanding, which might be otherwise identified as "technical specialist" occupations.

The Technician's Preparation

But if there is reasonable agreement on the nature and the function of the creature at work, there is considerably less than agreement on how he can be created. This does not mean that it is fruitless to attempt to increase the understanding of the technician by examining the processes of his manufacture. Rather the indication is that he can be put together in more than one way and indeed working models are being fashioned by half dozen or more different production methods. There would be great usefulness in establishing valid cause and effect relationships between the processes of preparation and the significant characteristics of the finished product. In the U. S. Office of Education Bulletin previously cited, Occupational Criteria and Preparatory Curriculum Patterns in Technical Education Programs, the Assistant Commissioner for Vocational Education, says:

> There remains, however, a need for a more precise analysis of the relation between the function of the "technician" and the education that can most effectively meet these requirements. (Occupational criteria, 1962, p. 2)

To take a look at the various patterns of preparation for engineering and science technicians* it is easiest to quote from the Occupational Outlook Handbook. (Handbook, 1966, pp. 224-227)

> Young men and women who wish to prepare for careers as engineering or science technicians can obtain the necessary training from a number of sources, including specialized formal training programs offered in post-secondary schools--technical institutes, junior and community colleges, area vocational technical schools, and extension divisions of colleges and

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* Identification in Third Edition, Dictionary of Occupational Titles, 002 through 029

universities--and technical and technical-vocational high schools. Persons can also become qualified for technician jobs by completing an on-the-job training program, through work experience and formal courses taken on a part-time basis in post-secondary or correspondence schools, or through training and experience obtained while serving on active duty in the Armed Forces. In addition, many engineering and science students who have not completed all requirements for a bachelor's degree, as well as some other persons with college education in mathematics and science, are able to qualify for technician jobs after they obtain some additional technical training and experience. In general, post-secondary school technical training is required for high-level engineering and science technician jobs.

To these should be added the training opportunities in technical and subprofessional occupations offered under the Manpower Development and Training Act. During the period from August 1962 through December 1966, 53,200 persons (Manpower Report, 1967, p. 227) were enrolled in training projects at this level in both institutional and on-the-job situations. This is approximately 8.9 percent of the total enrollment of 598,700 for the same period. Increased opportunities will be available under certain titles of the Economic Opportunity Act now transferred to the Department of Labor's Bureau of Work and Training Programs.

Also of far more than passing interest should be the fairly recent appearance of four-year programs leading to a bachelor's degree in engineering technology. These may not have had much visibility because of the 70 or more institutions reported to have such programs, only four are ECPD accredited schools. It is gratifying to note that the ECPD which has long been accrediting technical education programs within engineering-related technologies, took action in October 1966 (Engineering Manpower Commission, 1967, p. 50) to include in its program of evaluation for accreditation these four-year baccalaureate programs in engineering technology. Also with only minor dissent the American Society for Engineering Education which has had a Technical Institute Division for years, has recognized the usefulness (Engineering Manpower Commission, 1967, p. 39) of these four-year programs in developing high-level support personnel for the engineering profession.

The Federal Government gave evidence that it regarded the geographically uniform development of technicians too vital to the economic strength of the country to leave it totally to local or private initative and resources, with the passage of Title VIII of the National Defense Education Act of 1958. The provisions of Title VIII for the training of highly skilled technicians were made permanent with the passage of the Vocational Education Act of 1963. Purposes for expenditures were liberalized and funds were increased progressively to the present level of 22.5 million dollars. In addition to the Vocational Acts, Congress earmarked 22 percent of an annual authorization of 1.2 billion dollars under the Higher Education Facilities Act for construction of facilities for public community colleges and technical institutes, as further testimony to its concern.

So far as industry's role in the development of technicians is concerned, such activities have been substantial. There are helpful signs that private industry may be willing to buy a larger piece of the enterprise of manpower development not only for the ends of its own manpower needs but also for the larger purposes of the health and wellbeing of the communities of the Nation. Under any division of the task it should be agreed that the best institutional training yields only a beginning worker who develops into an able hand only where the sound and the smell and the pressures and the social-industrial relations of the job are; and where the real masters of the art or craft labor and teach.

If engineering-technician programs of study were compared with some so-called industrial-technician programs, the latter would be found to have less mathematics and science but more experience in industrial processes, production methods and maintenance skills. They would also be shorter in length, probably less than two years.

Up at the other end of the band, typical four-year, baccalaureate engineering technology programs would differ from the two-year associate degree programs by moderate increase in the technical specialty* and large increases in humanities and social studies.

The interface between the four-year engineering degree and the four-year engineering technology degree would reveal a considerably heavier content for the former in mathematics and science and a lighter content in related technical studies.

* These comparative studies in same EMC publication, Chapter 9

This discussion has undoubtedly proven that the confusion in terminology and job classifications and the somewhat astounding range of educational programs aimed at training "technicians" have complicated the process of identifying the functions and corresponding educational needs of "highly-skilled technicians."

Considerable study and research, much of it empirical and operational will be required to untangle the threads. A worthy effort is seen in the neat design of the Penn State project to be discussed this afternoon.

Meanwhile the various brands of technicians appear to relate remarkably well to each other and to the other members of the team. The industrial technician works with the production processes of industry in planning, supervision, maintenance and coordination. The engineering technician uses his technical knowledge and ingenuity in solving the problems generated by the engineer's design. And the four-year super-engineering technician moves in even closer on the engineer to take up the slack caused by the impact of the "Grinter Report" of 1955 with its philosophy of a science-related approach to engineering education.

Fortunately all members of the team seem largely oblivious to the devious patterns and this makes a good image at a time, when under the "New-Careers" program of the Scheuer amendment to the MDTA we are trying to ease the para-professional worker into the arenas of the applied behavioral sciences under the noses of reluctant and suspicious professionals.

The Need for Technicians

In closing it may be appropriate to say a word about the projected supply and demand figures for technicians. The most educated guesses of our Bureau of Labor Statistics (Manpower requirements, 1966) predict an increase of 380,000 engineering and science technicians between 1963 and 1975 to a total of 1,000,000. This increase is expected to be due to continued industrial expansion; more extensive use of technicians as employers discover how they can enhance the effectiveness of scientists and engineers; increased complexity of products and manufacturing methods; and anticipated growth in research and development expenditures.

This amounts to an annual requirement of 38,000 just to fill new positions. Approximately 22,000 additional will be needed to replace losses due to death, retirement and transfers. The output of engineering and science technician training programs cannot approach such a figure so much of the demand would have to be supplied from such sources as upgrading, MDTA programs, armed forces separations, or college graduates or dropouts. It may not be possible to meet the projected demand.

To slightly misquote Alice M. Rivlin:

"What is clearly wrong with technician training is that we know so little about it."

REFERENCES

Engineering Manpower Commission of Engineers Joint Council. Trends in engineering technician enrollments and graduates. New York: EJC, 1967.

United States Department of Labor. Manpower report of the President. Washington: GPO, 1967.

United States Department of Labor, Bureau of Employment Security. Dictionary of occupational titles, Volume I. (3rd ed.) Washington: GPO, 1965.

United States Department of Labor, Bureau of Labor Statistics. America's industrial and occupational manpower requirements, 1964-1975. Washington: GPO, 1966.

United States Department of Labor, Bureau of Labor Statistics. Occupational outlook handbook, 1966-1967 Edition. Washington: GPO, 1966.

United States Department of Health, Education, and Welfare, Division of Vocational and Technical Education. Criteria for technician education: Suggested guide. Washington: GPO, 1966.

United States Department of Health, Education, and Welfare. Occupational criteria and preparatory curriculum patterns in technical education programs. Washington: GPO, 1962.

DEVELOPING TECHNICAL MANPOWER:
THE ROLE OF INDUSTRY

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As presented previously by Mr. Gregory, it is noted that technology, technical manpower, technical education, and technicians have several definitions. To remain "on target" for our discussion today, I am confining my remarks to those technical education programs designed for the preparation of technical personnel through two-years of post-high school study and work.

This presentation will be developed within the framework of three major questions.

1. What is the role of industry in the education of technicians?
2. How can industry best utilize the technician?
3. What does industry expect of education in the preparation of technicians?

What is the Role of Industry in the Education of Technicians?

I believe that the interest of industry, and the cooperation of industrial representatives, in technical education is proportionate to the role of technical educators, particularly administrators, in seeking the support and cooperation of industry. In my experience in technical education, from the institutional standpoint and as a representative of industry, I have always found a cooperative attitude and interest on the part of industry in assisting, in an appropriate role, the development and evaluation of technical education.

State and local industrial advisory committees have been actively working where state and local technical administrators have sought such assistance. The use of advisory committees is not a new idea to most of you here today, however, the degree of success or service you have received from such groups may be less than what you had hoped for in some instances. The contribution of such committees depends on the type of industrial personnel selected, the role or service expected of such a committee, the planning of the meeting, and the appropriateness of the agenda.

Recently Tennessee Eastman Company representatives have been working with a local area school in the organization of a cooperative drafting design program. Students who have completed a year of training are selected to work in the Company Engineering Department. These young men rotate at three month intervals on their assignments in the plant (three months in-plant, three months in school, three months in-plant, etc.). Job training in the Engineering Division includes assignments in the drafting equipment group, heating and ventilation group, electrical group, and process and service piping group. This is but one illustration of the role of industry working in cooperation with a local institutional program to train technicians.

We have noted at the national level the contribution of business and industrial representatives in the development of the technical education program series printed under the title of Suggested Post-High School Curricula. Industry can provide resources of a consultant or advisory nature that make a very meaningful contribution to the education of technicians.

Role of Industry in Initial Education. The term "initial education" refers to learning experiences resulting from instructional courses and subjects, which are a part of the two-year post-high school technical curriculum. I believe the role of industry in this, the basic preparatory phase of the institutional program, is one of clearly understanding the program objectives, levels of competence in technical lab work, and the technical related courses required in each technical area of specialization. The responsibility of the institution in this regard is to keep industry informed of major curriculum changes that may affect the end product — the technical school graduate.

Industry expects school officials and instructional personnel to develop a program which is in keeping with state and national objectives and which lives up to regional and nationally recognized accreditation standards. You are in a position to know what the recommended standards are, how they should be interpreted in the structure of your curricula, and, most important, the effect that they have in developing the competencies of your technical school graduates.

Because industrial representatives are usually not as familiar as institutional personnel with national and state objectives and trends in technical education, the interpretation and implementation of these in the institutional program is primarily a school responsibility. The role of industry, on the other hand, is to help the institution to evaluate the performance of the technician on the job and to suggest educational experiences that may reinforce the program. Probably one of the most important contributions of industry is to assist the technical school in keeping up-to-date as changes occur in industrial methods, equipment, and manufacturing processes.

Technical obsolescence of technical personnel on-the-job is of increasing concern to industry. This brings us to the second point.

Role of Industry in Continuing Education. Continuing education on the job may include rotational assignments in a number of work areas in a plant such as maintenance, engineering, production, and work methods, just to name a few. In-plant training seminars on special equipment and vendor sponsored training classes are other types of educational in-plant experiences for personnel development.

Continuing education at the institutional level has tremendous possibilities for technical educators in the years ahead. Unfortunately, these services may be limited primarily to those technicians employed in an area served by a local technical institution. However, provisions for off-campus evening technical courses, much like those carried on by senior institutions, may be the answer to this problem. No doubt many of your school personnel are working with industry at the present time in preparing and offering continuing technical education services.

After a technician has been employed for a period of time, he often identifies other technical areas of interest, very meaningful to him in terms of his day to day job responsibilities, that can logically be provided through a continuing technical education program. Industry should have an interest in, and a responsibility for, assisting in the development of continuing education services. In some instances, it may be entirely feasible for the industry to provide the space and laboratory equipment for such courses with the school providing for instructional services. A program of continuing education for technicians of the type just described necessitates very close coordination by industrial representatives and school officials. In a large industry, the company training department can assist in identifying needs, developing time schedules, and notifying plant personnel of available courses.

Another fact that we should all recognize is that many technicians, after a period of industrial employment, will participate in university level courses to prepare themselves as engineers. I think this will continue, and perhaps to a much greater degree, in the future. Some technical educators have expressed concern that technician graduates are lost from the work force as they prepare themselves to become engineers. This may be true to some extent, but this upward mobility is a self-improvement objective for many individuals in semi-professional and professional fields of endeavor. A technician may be more valuable as an engineer for having had the training and experience as a technician. Perhaps it is costly to prepare technicians for a specific occupation and have them later qualify for other types of job assignments. On the other hand, how could we possibly suggest that an individual not plan for his own growth and development?

The contribution of industry in support of personnel development programs is significant. Tuition aid, educational leave, apprenticeship, supervisory and management development, just to mention a few, are further illustrations of the role of industry in supporting continuing education programs.

Should Industry Assist in Developing Educational Programs for Technicians? There are several approaches to this question. Financially, industry assists the state and national programs through taxes and through grants to educational institutions. Although specific grants may not necessarily be made directly to technical institutes or area schools, such institutes do benefit in many ways through our system of state and federal taxation. Industry can assist by notifying the school of special needs for technical courses and frequently can help recruit evening school instructors to conduct special classes. Plant equipment may often be made available to the schools to assist the instructional program.

It is very important that industry assist in the development of technical programs. The role of industry should be one of assisting and supporting these educational programs through advisory committees and other services of this nature.

Decisions regarding the internal structure of the technical programs (administration, instruction, physical facilities, instructional equipment, etc.) should remain the primary responsibility of the technical educator. A cooperative relationship between industry and the institution is important in assuring that the technical student is prepared to become a productive member of the industrial team.

As stated earlier, the subject of technical obsolescence should be of equal concern to both industry and the institution. To avoid such obsolescence the exchange of information regarding job requirements, responsibilities, skills, and technical knowledge must be frequently examined by those responsible for employing the technician and those responsible for his educational preparation.

To digress for a moment, I would like to illustrate the producer-consumer relationship in our industrial activities. In product development and marketing, industry must be sensitive to the consumer needs and saleability of its products. To maintain an awareness of these important factors, it is essential that industry maintain the necessary communications with the consumer. The availability of the materials, quality of products, consumer production problems, changes in marketing requirements, and other such concerns are of mutual interest to both parties. Likewise, your products -- well educated and well trained technicians are of considerable interest to the consumer (industry, business, social services, medical agencies, etc.), and the same dialogue between technical institutions and industry, as between producer and consumer, is most appropriate.

Industry can and does contribute much to the development of programs of technical education.

How Can Industry Best Utilize the Technician?

The full utilization of a technician's abilities in industry depends upon many factors. The nature of the industry itself is an important element and one that technical educators should understand and appreciate. There are considerable differences in the job assignments of technicians in defense or research related industries and assignments in industries manufacturing normal consumer type products. So the matter of utilization may differ from one industry to another. We have product development laboratories, research laboratories, and technical service laboratories, but thus far the majority of our technicians are working in engineering, maintenance, and production areas. There are probably other areas where we can use technicians to advantage. However, I should point out that until recently we had very few two year AA degree technicians employed in our work force. This means that only in recent years have we had the opportunity to appraise the competencies of these individuals on the job and to determine what appropriate levels of responsibility they may be able to assume.

The full utilization of industrial manpower in the skilled, technical, and professional groups of its employees is, I assure you, a constant concern of management. The subject of proper utilization of technicians in business and industry is one in which technical school representatives may be of considerable assistance to industry. Does industry really understand the objectives of your programs, the competencies of your graduates, and your willingness to modify programs to meet changing industrial requirements? On occasions, it may be appropriate for the institutional representative to suggest to industry possible ways in which a technician can be more effectively utilized. Perhaps an occasional seminar on the subject of utilization, with both industrial and institutional participation, would have beneficial results for both parties. Again, I would point out, that effective use of manpower is a primary concern of industrial management.

How Should Technicians be Evaluated? Two important aspects of evaluation are involved with respect to technicians. These are 1) the data and information made available by the employer to the institution regarding the performance of the technician on-the-job, and 2) the employer's method of evaluating (techniques, instruments) the technician for purposes of promotion or for additional job responsibilities.

The practice of securing periodic, or annual, reports from some of the industries employing your technical graduates could be very meaningful to both parties. These reports would assist in keeping up-to-date information that would be extremely helpful in the structure of your preparatory curricula. Such information may also be of value to school officials in assisting industry's effort to make the best possible utilization of technical personnel. Most industrial organizations have annual or semi-annual evaluations of all employees. Often these are in the form of performance ratings which may include such factors as skill, technical knowledge, personal characteristics, cooperative attitude, and personal development.

The evaluation of an individual's job performance in terms of competencies developed in the two-year technical preparatory program would necessitate another approach if it is to be meaningful to the institution. The determination of these factors would require an evaluation by selected individuals in industry, coming together with institutional personnel to discuss the performance of the technician(s) in his (or their) particular job. If, for example, you wish to determine how well your mechanical technology graduates are performing in a particular industry, this can be accomplished through discussions with their immediate supervisor. The individuals who are responsible for the daily supervision of these technicians are in a position to give the most valid and useful information. Your problem is one of determining the appropriateness of this information in terms of the content of your preparatory program in mechanical technology.

Industry can appreciate the fact that in the two-year program you can only include a selected number of courses and that graduates of the technology program must be prepared for employment in various types of industry. You cannot be expected to train technicians for a specific, specialized type of industrial occupation. This fact, of course, has implications for the continuing technical education programs previously discussed in this presentation. Specialized training can, and often does, take place after employment in in-plant training programs or through the continuing education program.

When industry evaluates technicians it considers factors which are often overlooked by students and school officials. Among these are the ability of the individual to work cooperatively with his supervision, to follow instruction, and to carry through a job to completion. Frequently it is found that unsatisfactory job performance in skilled and technical occupations is not due to a lack of skill or technical knowledge, but to an inability to follow instructions and to work cooperatively with fellow employees.

What Does Industry Expect of Education in the Preparation of Technicians?

This is a rather difficult question to answer. Due to the variety and complex nature of industries today, the requirements of one type industry may be considerably different from the needs of another. The individual who is describing what industry expects of education in preparing technicians would necessarily include comments based on his personal experiences and observations. With an appreciation of these limitations, it may be appropriate to consider the following factors in the educational preparation of technicians:

1. A core curriculum consisting of sufficient technical courses in a given technology to assure the development of competencies in basic skills and knowledge. The core curriculum should prepare the student for employment in his particular technical speciality in industries of various types.

2. Learning experiences in technical courses that develop personal adaptability and flexibility in applying knowledge in a variety of job situations. An assignment in a product development laboratory for an electronics technician may be considerably different from an assignment in the instrument maintenance group. In either assignment, with a reasonable period of orientation and experience, he should make a significant contribution to the group with whom he is working. Flexibility and adaptability are reasonably well assured if his basic skills and technical knowledge are sufficient for him to apply these in a variety of situations.

3. The technical program of studies should include experiences that develop an understanding and appreciation of the importance of personal growth and development on the job. A technician may become disappointed during his early period of employment because he feels that his services to the industry are not fully appreciated. This may be more apparent if the job is in a large industry with many divisions and services. Perhaps somewhere in his institutional program he should have an opportunity to understand more fully the organizational structure of a large industry.

4. Prepare the technician to understand the importance of job satisfaction and the ability to apply himself to the requirements of the job with a realization that, through experience and performance, opportunities will be enhanced and rewards will be forthcoming.

5. Provide educational experiences that develop the ability to use the media of written and oral expressions effectively. The preparation of technical reports is an important part of the preparatory program. Frequently technicians have difficulty organizing, preparing, and delivering technical reports which may often limit their opportunity for more responsible assignments.

6. The technical program should be designed to meet state, regional, or other types of accreditation standards. The salary structure within industry often provides special consideration for those graduates of accredited programs.

These are some factors I think industry considers important in the preparation of technicians. The responsibility for some of these elements of personal growth and development is shared by industry after the technician is employed. However, the institution should consider ways and means of instilling some of these understandings as the technician receives his preparatory education.

What Characteristics Should the Technical Graduate Possess? A number of reports and publications have contained information concerning the desirable characteristics of technical graduates. The American Society for Engineering Education has concerned itself with the subject of excellence in technical education. Some groups have listed technician characteristics under two categories-engineering technologies and industrial technologies. The licensing of technicians in medical and engineering areas and the recommended standards identified in these licensing procedures also refer to competencies or characteristics of technicians. To identify the desired personal traits and characteristics of a technician would require a listing of those factors common to all technical fields and another list of characteristics for a specific technical occupational area.

A drafting - design technician may need to develop skills in the testing and analysis of materials. The electronics technician should be competent in mathematics through trigonometry or perhaps calculus. These are examples of specifics.

Industry may suggest that the desirable personal characteristics of technical school graduates should include the following:

1. Good mathematical background.
2. Ability to express one's self effectively in written and oral reports.

3. Satisfactory understanding of necessary physical and chemical principles.
4. Manual aptitude required in the technology.
5. Understanding of an industrial organization.
6. Personal qualities that would enable the technician to become a vital member of the industrial team.
7. Sufficient laboratory and related technical instruction and experiences to enter industrial employment as well qualified technicians.

It is important that the educational institution attempt to prepare a well rounded, socially mature technician. How this can best be accomplished, in a given period of time, is of concern to each of you who are responsible for a leadership role in technical education. A persistent problem is how to distribute the time and courses in the two-year curriculum. How many technical laboratory courses, technical related courses, and general education courses can or should we include. No doubt some technologies may necessitate more than two years to complete the desired course work. Perhaps too frequently we are inclined to think in terms of courses rather than learning experiences or the development of individual competencies. Perhaps a better utilization of instructional time will bring about opportunities for enriched instructional experiences and understandings that will permit greater flexibility in the curriculum. The motivation and knowledge of young people today often enables us to accelerate their training activities.

In conclusion may I say that industry is much indebted to those of you who are responsible for the accomplishments in the development of technical education. Technicians are increasingly recognized as important members of the industrial team. Industry must seek ways and means of better utilizing the talents of technicians. You too have a responsibility in helping us to more fully appreciate your efforts in this respect. The interchange of ideas and information through advisory committees and civic and community groups is one important means of achieving a better understanding of technical education.

Often we become impatient with our seeming lack of progress, but much has been achieved in technical education. The growth and development of technical education these past few years has been one of the most significant developments in public education.

QUESTIONS ADDRESSED TO DR. THORNTON

From the Audience:

What is your attitude toward preparing technicians on a secondary level?

Dr. Thornton:

At the state level I had the opportunity to assist in the development of high school technical programs. I think some of these have been very satisfactory, however, some of them have just been industrial vocational programs with a new name. Many of the youngsters in one quality high school technical program I'm thinking of went on to college in pre-engineering. I think the technical program made a real fine contribution.

I don't know how many industries would actually employ high school technician graduates as technicians. I feel rather confident that we wouldn't in our particular organization. About the best that we could do would be to give some credit for this program in our apprenticeship program.

DEVELOPING TECHNICIAN MANPOWER: THE ROLE OF EDUCATION

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Greetings and best wishes to each of you! It is a real pleasure to attend and participate in this significant conference. Surely all of us - employers, educators and manpower specialists need to think, plan, and work together to meet the ever increasing demand for technicians in this technological age. The opportunity to talk with you regarding the significant role education has in helping to meet the need for technician manpower is appreciated.

Definition of Technical Education

Before we think about the education of technicians we should define what we mean by technician education. A technician education definition that seems appropriate for this occasion is one developed by an ad hoc committee called together by the U. S. Office of Education. The U. S. Office is making a noble effort to develop a taxonomy of words and phrases used in education so that educators, parents, students, manpower specialists, and employers may be able to communicate with each other more intelligently and so there may be some semblance of order for identifying educational programs whether offered in Hilo, Hawaii; Key West, Florida; Thief River Falls; Minnesota or in Holton, Maine. The technical education definition as developed by the ad hoc committee is as follows: (Standard terminology, 1967, p. 573)

> Technical education is concerned with that body of knowledge organized in a planned sequence of classroom and laboratory experiences usually at the post-secondary level to prepare pupils for a cluster of job opportunities in a specialized field of technology. The program of instruction normally includes the study of the underlying sciences and supporting

mathematics inherent in a technology; and of the methods, skills, materials, and processes commonly used and services performed in the technology. A planned sequence of study and extensive knowledge in a field of specialization is required in technical education, including competency in the basic communication skills and related general education. Technical education prepares for the occupational area between the skilled craftsman and the professional person such as the doctor, the engineer, and the scientist.

The technical education curriculum must be so structured that it prepares the graduate to enter a job and be productive with a minimum of additional training after employment, provides a background of knowledge and skills which will enable him to advance with the developments in the technology, and enables him, with a reasonable amount of experience and additional education, to advance into positions of increased responsibility.

This definition for technical education implies that many types of technician education are required because there are many kinds of technicians, just as there are many kinds of professional scientists. Many are employed in the physical sciences and related engineering fields. Examples are chemical, metallurgical, mechanical design or production, civil, electrical and electronics, and architectural technicians. Many others are skilled in the applied life sciences, particularly in the medical field and in the broad spectrums of agricultural research, processing and utilization.

Life science technicians are in medical and dental laboratories, dental hygienics, radiology, agronomy, horticulture, food processing, oceanography, animal science, soil science, agricultural production, and forestry or specialized plant science. Some combine life science and physical science disciplines, such as sanitation, pharmaceutical, or special clinical or hospital equipment technicians.

Objectives of Technical Education

What are some of the objectives for and characteristics of technician education programs? The objective of preparatory programs for educating technicians is to provide a broadly based competency of sufficient depth so that the graduate technician may be employed in one of a cluster of related work opportunities in his field. Upon employment, a brief period of orientation to his particular duties in the employers' organization, together with continued on-the-job study, permit him to advance to high levels of productivity and increased responsibility.

Educational programs to prepare technicians for their work as assistants to scientists must provide them with an understanding of the basic principles of their fields of science, and of the related science and mathematics which support their main field. They must also absorb a comprehensive knowledge of the procedures, materials, devices, techniques, equipment, and processes used in that scientific field and learn to use them easily. They must develop the ability to communicate with the professional scientists or engineers with and for whom they work.

The technician through his education must learn to employ the mode of thinking and intellectual discipline embodied in the scientific method, the ability to seek and find pertinent information, and the capability to work with both the scientist and the skilled workman or other aides to accomplish a variety of work assignments.

Programs

Quality programs for educating technicians are characterized by intensive classroom and laboratory learning. About 50 percent of the curriculum is the study of specialized subject matter in classroom and laboratory work. A planned sequence of courses emphasizes scientific principles and provides practice with equipment, and skills as they are currently used.

Mathematics, as required, is taught early in the technician program to obtain maximum utilization of its support of the study of the applied science. Communication skills and reporting are taught and practiced; and elementary study of economics, industrial organization, and human relations provides a frame of reference to the student technician as a member of society and as an employee of a working organization.

Several types of schools offer technician education, most of which are post-secondary. Of these, the greatest number of graduates are from community colleges, technical institutes, and area vocational and technical schools. Technical and comprehensive high schools also offer such programs to a limited extent; their orientation toward the needs of technical and related vocational education is of great importance since they may prepare students to enter technical education programs upon graduation from high school.

One cannot consider technician education without examining the characteristics of students essential for successful completion of post-secondary technology programs. In most cases students should have completed two years of high school algebra, one year of science and possess endurance for study and self-discipline to stay with the rigorous program to the end. The education path to success as a technician is not an easy one but it is not necessary for the student to be from the upper third of his or her high school class to satisfactorily achieve. Average mental capabilities, maturity, "stick-to-it-tiveness" are success factors. The momentary rewards are worthwhile and the work of the technician does provide satisfaction to those who complete technician curriculums.

While thousands of students are being graduated annually from two-year preparatory technician curriculums, there continues to be a desperate shortage of such personnel in many technical areas of employment. Also, the major effort in the schools providing technician education is not only preparatory in nature but it is also in the updating and upgrading programs for employed technicians. Rapid changes in technology requires employees to continue their study. Fortunately, technicians graduating from quality preparatory programs are well equipped, both emotionally and mentally, for continuing study. It is certain that in the forseeable future updating and upgrading education for employed persons will be a significant program in educational institutions providing technician education.

Quality technician education is difficult to provide. Furthermore, it is costly. Laboratories well equipped with equipment and apparatus representative of that used in up-to-date establishments is required either in the school or it must be available for use by the students through cooperative arrangements with employers; a competent, well-trained teaching staff is a must; administrative direction, sincerely dedicated to technician education is essential; and library resources must be of sufficient quantity and of high quality.

Someone has said it takes a minimum of five years and many thousands of dollars to establish a new technician education program. The chore of assembling staff; equiping facilities; and graduating the first class or two is not a simple task. However, when graduates become successfully employed and confidently advertise their success to their parents, friends and neighbors, the program is well on the way.

One of the most serious challenges facing technician educators is keeping programs high in quality and up to date. The most successful procedure for assuring quality and up-to date programs is for educators to use the advisory services of technician employers and manpower specialists. Outstanding technician programs are found in institutions where the guidance and assistance of employers and manpower consultants are used to a maximum extent. Walter F. Carey, when president of the Chamber of Commerce of the United States clearly stated this fact. He said: (Carey)

> The businessman is the key element in this whole education picture. Far better than any educator, or government administrator, he is in a position to know what his company's skilled manpower requirements will be for the next five years, the next ten years. And the smartest thing he can do is to let the educators in his community in on the secret so they can adjust their program accordingly....Some communities that now are operating effective vocational-technical schools have as many as 43 advisory committees involving up to 500 businessmen. Here trained management men put their knowledge and experience to work on the real core of the problem: How best to prepare men and women for productive jobs that exist today and for new opportunities that will open before them as our technological revolution progresses.

Much needs to be done by educators to more fully utilize advisory service of potential technician employers and manpower advisors--this advisory service needs to be used for the determination of programs to be inaugurated; for assistance with planning courses and curriculums; for establishing facilities; for securing staff and keeping staff up-to-date; for placement and follow-up of graduates; and for program revision. Educators are admonished to utilize such advisory services.

Included in the role of education in developing technician manpower is the opportunity to assist students at the high school level to prepare scholastically and emotionally for successful pursuit of technician education. This means there is need for pre-technical programs in the high school. These programs consist of basic science, mathematics, communication skills and introduction to specialized subject matter. The provision of specialized subject matter in the high school pre-technical program is essential to make the mathematics, science and communication skills real as well as to provide certain basic skills that may be saleable upon graduation from high school, if the student does not continue his or her education.

Furthermore, it is extremely important for post-secondary institutions to provide pre-technical programs for those students who have graduated from or left high school without the scholastic ability essential for successful pursuit of a high quality technician program. Such pre-technical programs can effectively increase the number of students who can successfully complete a technician education program.

It is only appropriate that consideration be given to some of the problems that tend to inhibit the fulfillment of the role of education in the development of technician manpower. Consideration should be given to the following:

1. Improved status for the technicians in the work-a-day world is sorely needed.

2. Supporting research, such as: Identification and definitions of emerging technologies; plans and designs for technician education facilities; and the development of curriculum and instructional materials.

3. Extensive development and use of educational technology in technician education is urgently needed. Programs should be self-pacing in nature.

4. Competent teachers, teacher aides, administrators, supervisors and teacher educators in the field of technician education.

While this conference has been concerned primarily with technicians, it is important to recognize that there is a wide range of specialized occupations which support and assist professional personnel and the technician is only one of these. The occupational equivalent of the technician is required in the financial and administrative management sector of jobs and in marketing, transportation, and servicing of the products of industry. The education of men and women who support specialized management is a part of the task of our local educational institutions, particularly community colleges. Their programs must meet and serve the supportive personnel demands of professional leaders employed in many fields. Programs for educating such occupational specialists are frequently offered in institutions which offer technician education. The shortage of qualified applicants for all of these employment opportunities is a major problem and a genuine challenge to educators.

Summarizing briefly - education does have a very important role in developing technician manpower.

1. At the present time thousands of such personnel are being graduated from post-secondary institutions annually. However, the number being produced is far from meeting the demands.

2. The most appropriate institutions for such education programs are post-secondary, particularly the community college and technical institute.

3. There is a need for pre-technical educational programs in high schools and in post-secondary institutions.

4. Advisory services of technician employers and manpower advisory must be an extremely significant part of technician education programs.

5. There is a large number of specialized workers that support and assist professionals and the technician is only one of these. Education has a role for meeting the demands for other supportive personnel, too.

6. There are problems inherent in providing technician education. Included are: Improved status for technicians; supportive research; maximum utilization of programmed instruction; and an adequate supply of educational manpower for technician education.

The opportunities and problems in the development of technician manpower are our challenge--let all of us.... educators, technician employers and manpower specialists work together to meet the challenge! Thank you.

QUESTIONS ADDRESSED TO MR. KNOEBEL

From the Audience:

How can we provide a comprehensive technical program in our community colleges and still satisfy accreditation requirements?

Mr. Knoebel:

This is a very good question and I think it is primarily a matter of working with accrediting agencies. Actually accrediting should be based on the objectives of the institution. I believe that the answer must come from all of us working with these accrediting people, to acquaint them with the real objectives and the need for these programs. The problem is the accreditation of programs staffed by persons lacking "academic respectability." Another problem is the lack of what they consider to be adequate general education courses in the curriculum. We have to educate them and solicitate some outside help from employers. We have the example of this from across the country. In Wisconsin, for example, adult vocational programs are accredited without too much trouble. The executive secretary of the accrediting agency made the statement that they recognize the value of the so-called related disciplines of the occupational program as being equivalent to the formal general education that is used for transfer purposes.

From the Audience:

Do you believe technical education can begin in the tenth, eleventh, or twelfth grade? If not, why not?

Mr. Knoebel:

Yes, it can begin in eleventh and twelfth grades. My only feeling is that it is possible, but not practical. We can find throughout the country certain high schools doing an outstanding job. Most of them operate under conditions which leave a question. I think of Brooklyn Tech, for example. First, it is a four-year program. Second, they select about 1,000 students from about 5,000 applicants. Third, they operate on a seven or eight period day. It's a long day.

The last time I heard the percentage of those graduating from the technical programs continuing in higher education was either 85 per cent or 90 per cent. Is this really technician education?

The secondary schools have a tremendous role to play in the total technician training. There is a good opportunity for a pre-technical program in the secondary school to prepare young people for technician training.

The technician type program does not require a student from the top third of his class to be a successful technician. Certainly a motivated person with average ability, can prepare for, enter into, and progress in the technical occupations. My plea would be for secondary schools to take a look at what they might do to provide a pre-technical program.

REFERENCES

Arnold, Walter M. The federal government's role in the training of technicians: Research management Volume VIII, Number 6. Washington: GPO, 1965.

Carey, Walter F. The development of our manpower resources: Three speeches by Walter F. Carey. Washington: Chamber of Commerce.

Miller, Aaron J. Research priorities in technical teacher education: A planning model. Washington: GPO

Ohio State University. A report of a national research planning conference in technical education, January 10-11, 1967.

United States Department of Health, Education and Welfare, Office of Education. Criteria, evaluation, and statewide planning for technical education programs. A Report of the National Clinic on Technical Education Programs Under Title III of the George-Barden Act and Vocational Education Act of 1963. Coca Beach, Florida, October 12-14, 1966.

United States Department of Health, Education and Welfare, Office of Education. Criteria for technician education. A Suggested Guide. Washington: GPO, 1967.

United States Department of Health, Education and Welfare, Office of Education. Pretechnical post high school programs. Washington: GPO, 1966.

United States Department of Health, Education and Welfare, Office of Education. Standard terminology for instruction in local and state school systems. Washington: GPO, 1967.

TECHNICAL MANPOWER
AND
INDUSTRIAL DEVELOPMENT

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As I prepared the text of my presentation for this conference, I mused to myself what it was that I could bring to this impressive gathering of thought leaders which would have some lasting effect. At a time when the term "manpower" has assumed such awesome proportions — it's something politicians invoke daily — educators "research" monthly — industry "lacks" regularly, there seemed little that I could add that indeed would be lasting. At wits' end, it was Madison Avenue that came to the rescue and while not exactly lasting, I'm informed that this neatly-packaged deodorant will give you at least 24 hours' protection.

Ridiculous though this example may be, it carries with it a revealing commentary on our times. Neatly prepackaged solutions are being proposed daily to solve our more perplexing manpower problems. The panacea for the politician is all too often indiscriminate application of the taxpayers' dollars, for the educator it can be research "overkill", and for the industrialist an impatient concern with today's problems at the expense of tomorrow's profits.

Freely translated, we don't have enough time, people, facilities or resources to be concerned with manpower training. Somewhere between the three lies the key to effective manpower management, and this I propose is the thrust of our deliberations here today.

First of all, let me set the stage with a few words about Pennsylvania's employment growth as a whole. I'll follow this up with a brief word on Science and Engineering technology education in the Commonwealth, and finally and probably most important in terms of making more than a 24-hour anti-perspirant contribution to the conference, I will attempt to outline what the State Government's role should properly be in assisting the development of technical manpower.

Employment in Pennsylvania

The 25 years between 1940 and 1965 saw a steady decline in Pennsylvania's share of national employment. To keep up with other States, Pennsylvania needed to add about 2-1/3 million employees; it fell short by a million. The million means general and continued problems in the State's economy. Some problems are in the form of slow-growing industries, like mining held over from previous eras; others are more basic, like climate or transportation, which affect the desirability of the State as a location for any new industry or expansion of presently located industry.

The employment lag can be divided into two parts, roughly corresponding to the two facets of the problem. The first is that part resulting from the State's mix of generally fast and slow-growing industries — (mix effect). This is computed by determining what Pennsylvania's employment growth would have been over the past 25 years if each industry in the State had grown at its national rate. The difference between this rate and the national growth rate is then the effect of the mix of industries. The most notable feature of the mix effect is its decline in importance. Between 1940 and 1950, the mix of industries accounted for 37 percent of the lag in Pennsylvania; but between 1960 and 1965 it had fallen to twelve percent of the lag. The heaviest contributor to the reduction of the mix effect was mining followed at a little distance by textilies, railroads, machinery and electrical equipment.

The second component with which we must be concerned is the difference between the rate of growth of each industry in the State and its rate elsewhere — best described as the "competitive" effect.

Though this segment has generally been more negative than the mix effect, we can again, by observing the size of the competitive effect of each industry, get a trend idea of which industries have the greatest potential in the State. For instance, between 1958 and 1965, the industries in which the State achieved a positive competitive effect were generally non-durables (food, apparel manufacturing, rubber and plastics). Of the few durable industries, lumber, furniture, instruments and aircraft stood out. Segments of the apparel industry having a good growth record in Pennsylvania are, like the rest of the apparel industry, sensitive to labor costs. As Pennsylvania's labor is somewhat more expensive than that of many other parts of the Nation, there is no reason to place much hope in further growth in the apparel sector. Exhaustion of the unemployed female labor force in mining areas serves to reinforce this conclusion.

The good record in certain food processing industries is probably the result of increased importing of food in conjunction with the Delaware River Port area. The only real bright spot among non-durables is rubber and plastics. Generally located around large metropolitan areas where it can take advantage of a large skilled labor force, it has made excellent use of the products of the petroleum industry which is strong in Pennsylvania.

Aircraft and instruments stand out among the durables industries. Both have fairly obvious explanations. Growth of aircraft manufacturing in Pennsylvania since 1958 has largely been a result of the war in Vietnam and the space program, and has centered in the Vertol plants of Boeing and General Electric Plants. Already the State is assisting with some much needed planning for the hopeful conversion to a peace-time economy and the potential strains on the manpower components in this area. It has been said that the growth of instruments manufacture is explained by the relatively high skills of much of Pennsylvania labor. Growth in this segment which has been above the national average has had a favorable impact on the State's "mix effect." Needless to say, the supply of technologically skilled manpower will have considerable bearing on further growth in this area. So much for the industrial overview. Now for a brief commentary on science and engineering technology in the State.

Science and Engineering Education

I happened to recently review the September 1964 report of the Governor's Council of Science and Engineering in which a Mr. K. L. Holderman of Penn State was quoted as estimating that fewer than 1,000 technicians of varying degrees of qualification were graduating at that time each year in Pennsylvania, and that furthermore it was his estimate that 3,500 to 4,000 science and engineering technicians would be needed by Pennsylvania industry each year from then through 1970merely to maintain and not improve the State's relative industrial position. If we dare assume that only those graduating from professionally accredited engineering technology programs (and I understand Penn State is one of the few so accredited), Mr. Holderman's estimates have the State producing since 1964 approximately 1500 science and engineering technicians to meet a 1967 need of 12,000. When added to other national data which according to one survey showed some firms increasing their engineering technology staff by 182 percent over the period 1966-1975, and 35 percent for scientific technologists for the same period, the problem takes on a serious dimension.

Which way do we move? Toward the four-year baccalaureate in technology? Toward State-related branch campus? The community college? The vocational-technical school? Probably all have a certain rationale for acceptance. However, if we slip back into the problem of images -- who is it that should be most concerned with this problem? The educator - the political power structure - the captains of industry - the parent and the student. I suggest that they do not have the vaguest idea of what a technologist does--his importance to the team concept -- of the glamor engineer-laden industries. The D.O.T. tells him nothing and even if he had heard of the Dictionary of Occupational Titles, it stands to be a good chance it would read like a telephone book of unfamiliar names. What does come through, however, are words like "terminal", "vocational", neither of which is conducive to inspire much enthusiasm in a youthful world filled with exciting images of the "Pepsi Generation", "thinking young" with "tigers in their tank."

Perhaps at this point it would be well to stop and review the recommendations contained in the first annual report of Governor Scranton's Science Advisory Committee, dated August 1966. Are the conclusions still valid, and if so, what marks do we give the political sectors in their efforts to come to grips with the problem? I quote from the section dealing with Professional and Vocational Training:

> Clearly the need of modern society for highly trained personnel capable of learning new techniques and of supervising their use demands that we provide for our sons and daughters access to first-class professional and vocational training. We need sub-baccalaureate institutes for the training of technicians for science-oriented industries, and a continuing strong baccalaureate program for training professional technological and scientific workers. We need the ability to retrain, or to continue to train, individuals after they graduate from high school or the university. We need close liaison among industry and public schools and universities so that vocational and academic curricula are realistically geared to fit requirements. We need motivation of individuals to prepare for new opportunities of the future -- in technology, in the service industries, in the arts, and in state and local government.

To provide the highly trained personnel with the skills and background needed to fill job needs in modern society we recommend:

1. That the Governor support legislation and the Department of Public Instruction initiate programs implementing the State Board of Education's Master Plan, with emphasis on developing community colleges and technical high schools to train students for existing local job opportunities;

2. That the Governor create a "Manpower Mobilization Council" with members from industry, labor, civic groups, schools, colleges, placement agencies and the Departments of Labor, Public Instruction, and Commerce, to survey the trends in job opportunities and training programs in the several regions of our State and to recommend appropriate actions;

3. That the Departments of Commerce, Labor, and Public Instruction hold conferences periodically on trends in employment, opportunities and curricula for school councilors and officials, industrial representatives, and local civic leaders;

4. That industry locally maintain close contact with public school officials and councilors, and make known to them trends in job opportunities and training required to meet their needs;

5. That the Department of Public Instruction with advice from the Departments of Commerce and Labor institute programs to assist Pennsylvania's public schools to evaluate periodically the adequacy of their curricula and of counseling offered students, considering trends and needs in job opportunities both locally and generally;

6. That the Department of Public Instruction fund within the Pennsylvania public school system research and demonstration programs on educational technology, with the contractual assistance of the Learning Research and Development Center at the University of Pittsburgh.

As you undoubtedly know, Governor Shafer recently signed into law a bill creating the Pennsylvania Science and Engineering Foundation, hailing it as "one of the most significant pieces of legislation passed by the last session of the General Assembly." He commented:

> The potential of the Foundation is enormous. With it we can attract the best scientific and engineering brains available to take Governor's chairs in our institutions — men of the caliber who recently received the National Medal of Science in mathematics, science and engineering.
>
> These men will provide sophisticated leadership in attracting outstanding young scientists and engineers to our graduate centers.
>
> They will help us provide leadership in new endeavors in such fields as pollution, new materials, oceanography, nuclear power, biomedical engineering, communications, high-speed transportation, and research and development industries.
>
> The Foundation will be an important tool in helping bring in new research and development oriented industries--industries that produce twelve jobs in related areas for every person they employ.
>
> With the Foundation, I see Pennsylvania becoming a leader in developing centers of excellence in graduate education and advanced research in science and engineering. It will provide incentive grants to graduate departments of our universities, distinguished fellow awards and professorships and new research programs.
>
> The need for this brainpower development in Pennsylvania is clear. The Governor's Science Advisory Committee has pointed out that Pennsylvania produces less doctoral graduates in science and engineering than any other industrial State.
>
> The Committee also pointed out that neighboring states, such as New York, Ohio and Connecticut, have taken steps in this field that give them an industrial development advantage over our Commonwealth.

It is obvious to all of us today what is happening in the new industrial environment. Industry needs brains to function in this highly technical age, so it goes where the brains are.

On top of that, the Federal Government finances 80 percent of all research and development conducted in the United States. It is not insignificant that New York, California and Massachusetts have received more than 50 per cent of all Federal research grants.

So, it was high time we did something in Pennsylvania about it. What we have done is dramatic and will have far-reaching, meaningful consequences for our future growth.

Cooperative Effort

Finally, concerning the cooperative roles which must be played in assisting the development of technical manpower in the Commonwealth, clearly no one can walk this road alone. Each sector has a particular role to play, although there are varying interpretations as to what this should be.

Industry is wary of governmental invasion of the private sector, and not without some justification, I might add. The data which is so sorely needed by the so-called planners is often of such a sensitive nature that competitive advantages are threatened.

Educators, perhaps the most independent of the whole group, tend to plow and re-plow the same ground, often without grounding, as to the realities of the commercial world in which we live. This is not by way of being critical, but rather realistic.

We must all own up to our shortcomings before we can proceed with mutual confidence. The manpower training field itself is composed of many related but often unconnected disciplines.

Clearly the mandate is for someone to pick up the baton and set the tempo for the rest of the symphonic sections to follow. Mind you, this baton need not be the big stick of a Teddy Roosevelt but rather must carry the persuasiveness of a Eugene Ormandy commanding one of the country's largest aggregations. And have you ever noticed that once the symphony is started, the musicians seem to ignore the conductor entirely?

We have seen the need for this kind of coordination at the State level in the development of a Task Force which implies the establishing of priorities and joint cooperative effort by educator, employment service officer, school counselor, industrial developer and community assistance worker alike.

Frankly, our major problem is that most of the funds involved in manpower training today come from Federal sources; thus, we are not complete masters of our destiny. The words, "creative Federalism", have been uttered but have not been given any meaning. Perhaps the State is at fault for not having seized the initiative earlier. Nevertheless, it is now our job to attack those areas where we do have control.

In legislation, for instance, we should be looking at our protective youth employment laws which often prevent students from even developing a familiarity with a job title.

We should seek to stimulate training of the underemployed and the part-time worker.

We should see to it that the image of our vocational and technical high schools undergoes change and that these schools are filled to capacity.

Even more, we should make sure that this valuable skill production line, as it were, is operating around the clock.

Considering the taxpayers' investment in these places of learning, we would be remiss if we did not address ourselves to this problem.

PART II

FIELD-ORIENTED TECHNICAL EDUCATION

William A. Dunn
Associate Professor of General Engineering
The Pennsylvania State University

It is my task to tell you how we at Penn State developed this field oriented program in machine and tool design. When we were first approached regarding this program it was our understanding that the retraining would be for persons who were technologically unemployed through automation and technological advances, but when the class was enrolled it included several recent high school graduates, and those who were being retrained were in the minority. However, this had little or no effect on our development of the program.

The field-oriented program was planned and operated by the Department of Continuing Education in Engineering at Penn State. This Department has the responsibility, for most engineering programs that are offered away from University Park and those engineering seminars offered at the University Park campus. The Department includes representatives of the various engineering disciplines -- mechanical, industrial, and civil, as well as other types of engineers. All have an engineering education and industrial experience. Whenever we are approached regarding a program like this we usually work as a committee with each one contributing his bit, insofar as academic preparation and experience are concerned.

The Engineering Team

With Figure 1, I would like to explain where we felt this program should fit insofar as a field-oriented program is concerned. The title of this figure is The Engineering Team in Industry. There are two headings--The Individual and The Activity. Most engineering teams in industry today include similar elements. On the vertical dimension of the figure are the scientist, engineer, technician, and craftsman.

Going across the figure horizontally indicates, for example, that a scientist would use a preponderance of theory in his work, and a minimum amount of manual skill and application.

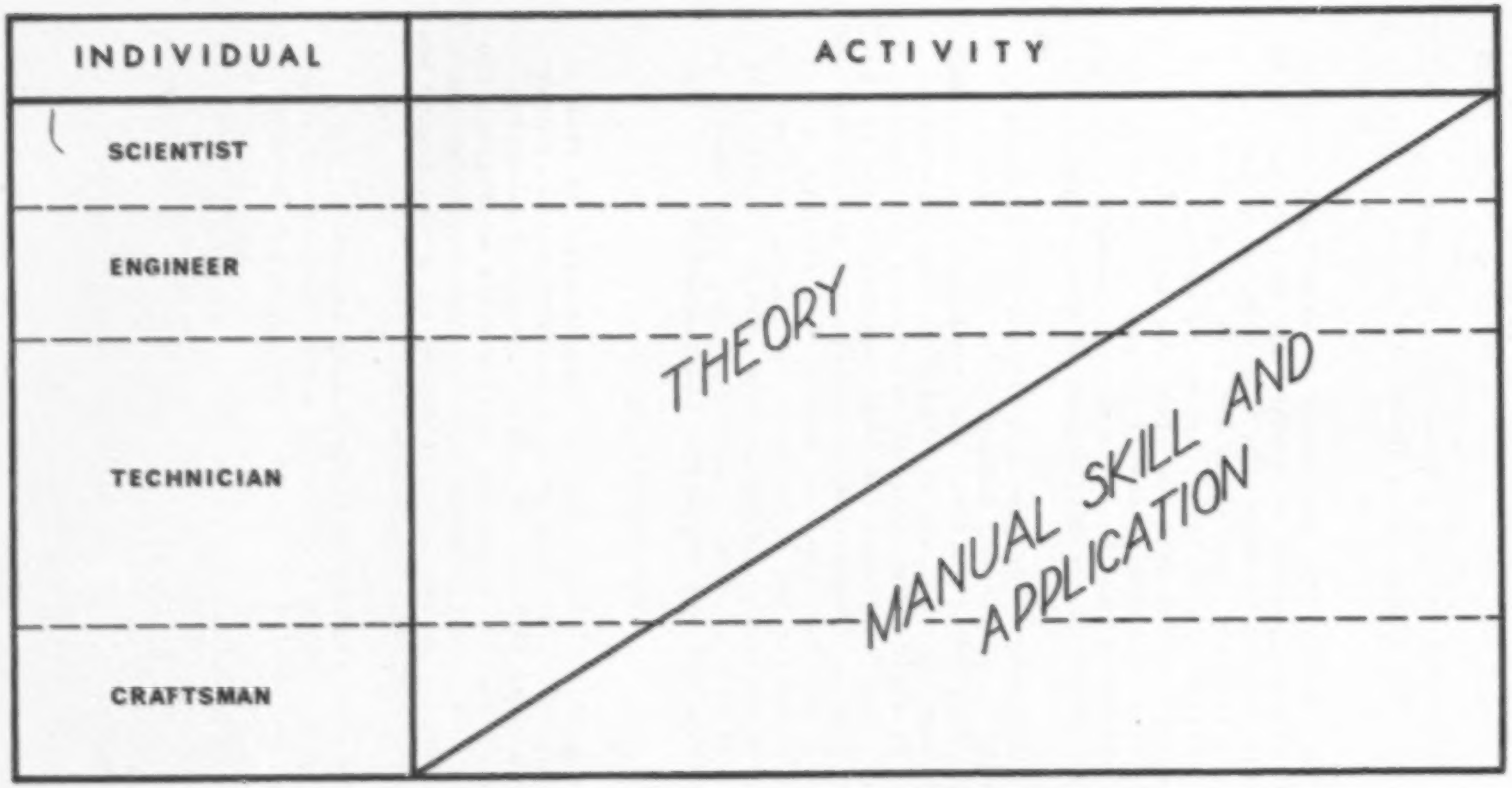
INDIVIDUAL
ACTIVITY
SCIENTIST
ENGINEER
TECHNICIAN
CRAFTSMAN
THEORY
MANUAL SKILL AND APPLICATION

Fig.1 THE ENGINEERING TEAM IN INDUSTRY

Vertically beneath the scientist is the engineer. He uses a lesser amount of theory and a greater amount of manual skill and application. At the bottom is the craftsman using a minimum amount of theory and a maximum amount of manual skill and application. In between in the widest spectrum is the engineering technician. There are engineering technicians trained to work closely with engineers, and technicians trained to work very closely with craftsmen. We envision the field-oriented program to be near the center of the spectrum of technicians.

Figure 1 is not drawn to scale and is probably subject to controversy. Any individual on the engineering team would work with all others. The scientist would be dealing with the craftsman and the engineer dealing with the craftsman and vice versa - but the technician has come into the foreground.

Program Objectives

The preceding was background. I would like to explain how we preceeded from there. Our objective was to train individuals to take their place in an industrial situation, primarily in a manufacturing plant in the tool design and tool engineering field. We wanted them to cross over into the tool engineering field and we wanted them to have additional background in machine design. This we had to do in the time specified--which was approximately one year.

In addition to developing technical competence, we also wanted these students to have some work in human relations and communications, both oral and written. We wanted them to have some work in engineering economy and a broad course in industrial organization. We wanted these people to first of all be technically competent when they went out into industry, and we wanted them to have sufficient background so that when they were in industry they would have enough background to assume some positions of firstline supervision when it came their way. We hoped eventually that some of these people would find their way into management functions.

Program Development and Operation

Knowing what we wanted to do, and the people we were going to work with, how were we to go about this? For quite a few years the continuing education arm at the University has been offering programs similar to this all over the state of Pennsylvania. During World War II we were heavily engaged with this type of work. We took this team that we have in Continuing Education in Engineering and we put a program together, as we saw it, and had an advisory committee go over it. This advisory committee was composed of primarily our part-time evening instructors. These people work in industry during the day and like to teach. We selected ten of these people, whom we knew personally, and gave them the program that we had developed and asked them to constructively criticize it for us. These people knew the scope and the level of our work and were employed in industry so they could constructively criticize this program. Through this process the program which was eventually offered was developed.

Because we knew these people were going to work 40 hours a week when they got into industry, and because we were told that the program more or less had to be fitted into a schedule like this, we came up with a program that was 37 1/2 hours a week in length. Actually these people went to school five days a week for seven and one-half hours a day.

The program was offered at our Altoona campus, which has a student body of over 800 in baccalaureate, and associate degree programs. Our faculty is rather large, including many engineers who we utilized in the field oriented program. You can see what would happen when a program involving 37 1/2 hours a week was put on a campus like that. Additional help was needed, insofar as the instruction was concerned. We went to industry in the local area of Altoona to secure teachers. Many of these potential teachers had been Penn Staters and were known through personal contact. Some of them had the desire to teach and they welcomed the opportunity. Industries in the Altoona area were most cooperative in giving their engineers release time to work with us. However, we did have to hold some classes in the late afternoon and early evening because some of the engineers who taught with this program could not be away from their jobs during the day.

Since the University was going to give completion credentials to the students who participated in this program, it was necessary for us to adhere to certain academic standards. Because of this, we lost some of the students. If a person failed a course in mathematics, or engineering mechanics, which was pre-requisite for another course, we unfortunately, couldn't allow him to continue. For this reason, twelve students were dropped. This wasn't done in a harsh and a cold manner. At the end of each term, we usually had a faculty meeting to discuss the students who were on the fence as to whether they were going to pass or fail. It was usually found that if a person was in hot water in one academic area that he really wasn't a ball of fire in another. Students were not dropped in a ruthless manner, but they did have to adhere to certain academic standards.

I am frequently asked whether this program carried college credit. The answer is no. It did not. The courses in this program were what we call our 900 level courses. These courses are not applicable towards a degree, either associate or baccalaureate, at the University. These courses were developed many years ago for people to gain an entry job into industry or for people who were in industry who wanted to upgrade themselves.

This program was rigorous in nature. I think if we were involved in future programs we would probably want to have a little time between terms. This program was seven terms long, with no breaks between. One term would literally end at seven on Wednesday night and another would start at eight Thursday morning, so these people really didn't have any time to catch their breath.

I am frequently asked too about the breadth versus depth of this program. I like to think that we probably have achieved both. We had breadth in the sense that we ran the gamet in tool design and tool engineering; we had machine design and humanities courses; we had courses in industrial organization, engineering economy and communicative skills to help these people when they were employed. We also had a fair amount of depth in the tool design engineering field.

Graduates of the field-oriented program were very readily employable. However, I cannot say whether the general economic condition, with jobs easily obtained, had anything to do with this.

The growth potential of the graduates, I believe, is very good. We have had experience with this type of program in evening classes and graduates from a program of this type have assumed positions of responsibility in industry.

This is a fast over-view of the program as we conducted it at Altoona. I may have left a lot of vacuums which will generate some questions to be discussed later. Thanks kindly.

QUESTIONS ADDRESSED TO MR. DUNN

From the Audience:

What was so different between this field oriented program and an associate degree program?

Mr. Dunn:

The difference between the two programs was primarily that we have courses that are designed specifically for the associate degree type of work. These are of the 800 series and are applicable only towards an associate degree. The program offered under this research project was structured under our 900 series courses which are not applicable towards any degree.

The emphasis in the 900 series is not nearly as great insofar as the mathematics are concerned. The treatment of various subjects as engineering mechanics and mathematics is not nearly as rigorous. An analogous question might be to ask the difference between mathematics and engineering mechanics in an associate program as opposed to that in a baccalaureate program. The difference is primarily in the depth of coverage.

From the Audience:

You gave the impression that the associate degree courses carry college credits. Is this so?

Mr. Dunn:

I didn't want to give this impression. The Pennsylvania State University has programs that lead to associate degrees in engineering technology, drafting and design technology, and electrical technology. These programs are designed to utilize the 800 series courses. These are two-year programs and until this past year have been terminal programs in the sense that they were not applicable toward a baccalaureate degree. However, last September the University at the Capitol Campus began offering a four-year program in engineering technology that leads to a baccalaureate degree. The entrance requirements for this may be satisfied by having an associate degree from an ECPD accredited program.

From the Audience:

If you had to do it over again, what selection factors would you recommend be utilized in choosing the group that would most benefit from the program you developed?

Mr. Dunn:

This is a rather difficult question to answer because we do have an attrition rate in associate and baccalaureate degree programs. An attrition rate can be attributed to many things - motivation, insufficient background, and some personal reasons. For the type of program conducted in connection with this research project, the screening used was quite adequate for us. However, we still had an attrition rate. In a program like this we give an examination to determine the level of proficiency in mathematics. On the basis of this we have come up with some remedial work if necessary. In this particular program before starting algebra and trigonometry, on the basis of entrance tests, we did review some arithmetic. So there was this flexibility in the field-oriented program. I don't think the selection process would necessarily need any changes.

From the Audience:

Did the use of "green" teachers add to the attrition rate in Altoona?

Mr. Dunn:

This is always a debatable issue. Within the University structure, the credentials of prospective teachers are scrutinized by the academic department responsible for the courses to be offered. That department either passes on this person and gives standard approval or says "no" they can't teach this course. Technically and academically all the teachers were very competent to instruct in the courses they taught.

From the Audience:

Was there some fear among persons involved in the one-year program at the Altoona Campus that it would detract from the associate degree program? Was there fear that the one-year graduates would go out and represent themselves as two-year associate degree graduates and infringe on the reputation of the Altoona two-year program?

Mr. Dunn:

I think so. You will find people within our system who feel that the associate degree infringes on the baccalaureate program.

From the Audience:

Referring to the figure shown by Mr. Dunn, it is my observation that the proportion of time spent in theoretical as opposed to application and manual skill by members of the engineering team are not accurately shown. How much manual skill does an engineer use? In day to day activity, it is practically zero. I hired an engineer from one of our big universities and he had never seen a motor run. The engineer is not a nuts and bolts man and the span of his activities has become more limited. As the engineer has assumed more limited duties, technicians have been expected to fill that gap. We as educators are called on to prepare these technicians.

Industry has changed. Five years ago they were looking for a pair of hands for a specific job. Today they are looking for potential. If they can not see that the individual will develop in three to five years, they aren't particularily interested.

JOB-ORIENTED TECHNICAL EDUCATION

George W. Elison
Dean of Technologies
Lehigh County Community College
Allentown, Pennsylvania

Our philosophies are based upon many things. Experience plays an important role in developing a philosophy, thus the person with a strong academic background tends to consider formal academic education as the key to success. The person whose experience is more practical in nature may have an entirely different point of view. As I see George Parkes sitting in the audience today I can't help but think that when George hired me he was more interested in what I could do, and the practical experience I had than in my college degree. This has been very influential in structuring my philosophy of technical education, and the results may become evident to you as I present to you some of our thinking about the job-oriented program for tool design technicians offered in Allentown.

In comparing the job-oriented and field-oriented programs of training, we were unable to identify any real major differences in the curriculums as they were spelled out on paper. So rather than attempt to make minute comparisons of the programs, I will share with you some of the philosophy that I use in the development of any program. This will be done by briefly discussing ten points which I have called, "Considerations of the Staff in the Development of the Program."

Considerations of the Staff in the Development of the Program

1. The term "technician" is a broad term. This I'm sure is not very profound, but it is important to keep in mind that the term "technician" is a broad term. In talking with people in industry, we often use this term which may be interpreted in many different ways. I compare this with a situation I experienced last summer. I was bringing my boys back from a fishing trip in Canada. About three o'clock in the morning I was listening to the uninterrupted original

score from the musical "Oklahoma". I might note that I found the program very enjoyable. One of my younger boys woke up and said, "Dad, why don't you get some music on the radio?" His idea of music was obviously different from mine. I think this is often the situation we are in when we discuss technicians. We aren't always interpreting the term from the same base.

2. Technicians may be classified as "Engineering-Aide" or "Industrial". Technicians in general can be classified in two groups, the engineering aide, and the so-called industrial technician. The point of departure between these two is nebulous, difficult to pin down, and in all probability exists as a broad band in which both types of technicians have common responsibilities.

3. The need for industrial technicians exceeds the need for engineering-aide technicians. More industrial technicians than engineering-aide technicians are needed in the Allentown area. This is the basis upon which we built the job-oriented tool design program and upon which we have built subsequent programs.

The next seven points refer primarily to programs for industrial technicians and these may indicate some of the major differences in philosophies between the two programs.

4. The job of the technician can be identified. The duties of most technicians require a somewhat broad background. However, an analysis will permit the identification of the abilities required to function as a technician. Rather specific programs can be developed to prepare these technicians whether it be in the field of electronics, mechanical technology, civil technology or elsewhere. Although there are many disciplines involved in each of these technologies, contact with industry will permit the identification of the needs of each area of technology and a program can be structured to meet this need.

5. Neither vocational nor engineering education is entirely suitable preparation for a technician. The job of the technician will include some work similar to that of the engineer and some similar to that of the skilled craftsman. However, the educational program for preparing technicians should differ from that of either the program for the engineer or for the skilled craftsman. We are talking about a specific type of work which requires a specific training program. In the Allentown program, if we were to err in the structure of

the program, we would prefer to have more orientation toward the work of the craftsman, the draftsman, than toward the engineer. Here you can see one of the major differences in the structuring of the two programs.

6. Mathematics requirements are in the application of laws and concepts. The mathematics and science requirements for industrial technicians should be more of an understanding of the application of basic laws and concepts than a deep understanding of theoretical principles. For example, the technician should be able to analyze a problem, submit it to the most basic formula possible, refer to tables when appropriate, use the slide rule, rotary calculator or any other device which will expedite the solution to the problem, and come up with the answer in the quickest possible time. The industrial technician should master basic algebra, trigonometry, and in some cases geometry. A mastery of the theoretical aspects of mathematics, some of which are seldom used in industry should not be structured into the program. The same thing is true in the study of the sciences. Much of the physics which a technician uses does not require a mastery of calculus, but is based upon the understanding of a much more functional type of mathematics.

7. There is an entry level job in every technology. There are typical entry level jobs in any technical field and it is imperative that any program of technical education provide for entry competencies. For example, if the entry level job is on the drawing board, then the educational program must provide the student with the drafting skills which he can sell when he goes out on the job. If the technician does a poor job at the entry level he may never get the opportunity to show how he can apply math or physics or any other discipline to the elements of design. So again, one of our concerns in any program of technical education is that we include enough of the basics required for entry level jobs to permit the technician to become established.

8. Theory is most meaningful when related to the technology. Theory, whether it be in mathematics, mechanics or areas directly related to technology, can be taught more efficiently, with greater retention, if the student can see the application. The treatment of the course, whether it be math or physics as a discrete subject is highly arbitrary and in the long run can be detrimental to a program of this type. As I review our educational system today, we are coming to a point where mathematicians are inclined to consider the application of mathematics as degrading. Teachers are more

and more treating this as a discrete subject. The head of a mathematics department very pointedly said, "I can not apply mathematics", and he said, "I do not believe it is the job of the mathematician to be able to apply math." My reply to him was, "Then you are saying there are two types of mathematics, for math as you teach it has no counter part in life where we find mathematics used primarily as a tool. If combining application with the theory of math will improve the learning process, which I'm sure it will, then we should strive to have the math departments which can contribute in this manner.

9. Objectives of related instruction should be clearly defined. The objectives of supporting areas of instruction should be clearly defined in respect to the major purpose of the program, and structured accordingly. For example, the purpose of machine shop in our program was to provide an understanding of the capacity and limitations of the machines and not to develop skills. Once a student understood that certain design features such as close tolerances and fine finishes increased the cost of producing the tool, die, or fixture in terms of both skilled manpower and quality of machine, we had reached our objective. Whether or not the student could operate an engine lathe to a thousandths of an inch, was immaterial to us. An analogy to this is applicable as well in the general education subjects. For instance, rather than an introduction to psychology or general psychology course, which is a basic subject for four-year students, we should offer something like human relations which will prepare the individual to understand and work with the people he will encounter on the job. The supporting areas of instruction should be closely analysed, their objectives determined, and structured in relationship to the specific purpose of the program.

10. A technician needs some general education. A technician needs an understanding of some of the broader aspects of life such as communications, human relations, and economics. However, to reinterate my previous point, in the restricted time that we have in any two-year program of technology, these courses should be as functional and meaningful to the student as possible.

The ten points which I have listed influenced us greatly in the development of the job-oriented program. Some we were able to satisfy, others such as the human relations we could not work into the limited time. In this particular program there were also aspects of retraining which we had to consider because our operating funds were from the Manpower Development and Training Act. Since M.D.T.A. was paying this bill we had the responsibility to them to do everything within our power to see that the maximum number of students went out with saleable skills.

Early in the program we agreed that as long as any student showed us the characteristics which we felt were required of a draftsman we would keep him in the program. This was a philosophy that we had on retraining, not necessarily on mechanical technology per se. We gained many experiences from this. We took 35 students into the program, we graduated 32, of the three who left, two left at our request, not because they couldn't do the work but because they cut classes, were generally unreliable and we could not possibly recommend them for positions. Of the 32 who completed the program, two failed mathematics, mechanics, and strength of materials. The number of individuals involved is small, but we can observe no great difference in the work of those who flunked math as opposed to those who were making A's. On the basis of our experience we wonder whether we don't tend to set standards of performance, which, as far as industry is concerned, are quite arbitrary.

The second thing which we gained of this program, had to do with the recruitment of students. It seemed advisable to accept only people who had two years of algebra. However, algebra in the smallest district in the county is far different from algebra in the larger districts, and is not comparable in content or coverage. One student, I know, had no algebra at all and ended up tutoring some of the students who had two years of algebra in high school. So again, I think that some of our entrance requirements for some of these occupations can be arbitrary.

In the structuring of our program, due to availability of facilities, machine shop practice came early in the program. We were interested in developing some understanding of how principles of machine shop influence design so that in designing, students could consider cost and the equipment available. This posed some problems because at the time the machine shop was available, the class was just beginning to get into the ramifications of three-view drawings. As an outgrowth we decided that the first project in drafting, after learning three-view drawing, would be a design problem. This they did. After dividing into teams, individuals suggested designs which the team refined and presented to the class. Their first drafting assignment involved design, not very sophisticated, but entailing many of the things we wanted them to learn on the machines. The designs were taken into the machine shop and the objects manufactured. In manufacturing, the students were able to determine how design did influence the manufacturing process. We thought this was a very good educational experience and it opened some doors of which we had not been aware. Maybe you can learn designing without learning drafting as it is often taught. Too often drawing requires the reproduction of a plate without any thought of the relationship to the manufacturing process. We found that giving the students design problems early in the program seemed to add to their total understanding and motivation.

QUESTIONS ADDRESSED TO MR. ELISON

From the Audience:

What was the background of the design instructor in the job-oriented program in Allentown?

Mr. Elison:

He was chief tool designer for Mack Trucks. He had in the neighborhood of twenty years experience in industry at two or three different places. In terms of education he was self-educated. As a matter of fact, as I recall, he had had no formal college preparation, but he was acknowledged as being an expert in the field by the local industries.

From the Audience:

How was the day divided?

Mr. Elison:

We had a schedule that would kill you. We prepared for a program to enroll eighteen and were then told that we had to take 35. Our drafting room would accommodate eighteen, so we had drafting classes of eighteen and seventeen operating from 8 A.M. to 11 A.M. and noon to 3 P.M. -- two sections. After 3 P.M. we had math and in some cases metallurgy and production problems. We had classes until 10 o'clock at night. Every other week, for part of the year, a student would come in at 8 o'clock in the morning and would be responsible to be in a class until 10 o'clock that night with a break during the afternoon. This is one of the things which philosophically you don't like to do, but frankly it didn't bother them a bit. I could never see that it bothered them. But it was a terrible schedule for a student. I probably, myself, would have rebeled if I had had to put up with it.

From the Audience:

Would future technicians gain more understanding of production methods by observing skilled craftsmen than by actual student machine operation?

Mr. Elison:

I don't know - all I can give you is opinions here. As I mentioned I personally feel that the amount of machine shop time can be less than 250 hours. You not only have to identify the job you are preparing for but you have to identify the students you are working with. The type of student who typically comes into a program of this type gains by having a well structured program where he can get time on the machines. I would have to emphasize keeping your objectives in perspective. This can be a fight with the machine shop teacher because if you take tolerances and finishes away they have nothing upon which to grade. The job-oriented program in the future will be taught as a two-year associate degree program for the Community College. We plan to provide time in the machine shop and in the welding shop.

From the Audience:

What did you mean when you said you would rather err in the direction of the skilled craftsman than in the direction of the engineer?

Mr. Elison:

If I'm going to make a mistake in the planning of the program I would feel more comfortable about including more preparation for entry level jobs more closely approximating the preparation of the skilled craftsman than the theoretical aspects of engineering. This is probably the main thing that differentiates between the engineering aide technician and the industrial technician.

MANPOWER RESEARCH:
IMPLICATIONS FOR THE EDUCATION OF TECHNICIANS

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My report will cover the findings of the manpower training research project which have implications for the education of technicians. Before I discuss some of the specific implications, perhaps a brief review of the project is appropriate.

The job-oriented program prepared men for positions as tool design technicians while the field-oriented program preparation was for machine and tool designers in mechanical technology. The emphasis in the job-oriented training was depth in tool design preparation. Courses were selected which would contribute to the preparation of a tool design technician. The objective was to produce a person who could immediately, after the completion of training, contribute to the cause of his employer as a tool designer. This course was taught in a vocational-technical school and was in many ways similar to grades thirteen and fourteen in technical programs. School personnel together with a local industrial advisory committee prepared the curriculum.

The field-oriented training program emphasized breadth in mechanical technology with preparation pointed toward making the individual flexible in this field and ready to accept future opportunities for advancement and change. It was recognized that the product of this program may well need additional training after securing a job, but it was held that a wider variety of opportunities for employment would be open to him. This course was taught on a Commonwealth Campus of The Pennsylvania State University. This program bore some resemblance to an associate degree program or an evening school extension program. The curriculum was prepared by the College of Engineering in consultation with practicing engineers.

Selection

The two training programs were organized on a state-wide basis. In other words, students were selected from throughout the Commonwealth of Pennsylvania. The Pennsylvania State Employment Service was responsible for identifying and for initially screening applicants. This screening was done according to these criteria. Only persons eligible for MDTA training were considered. This meant that, among other things, each applicant must have been unemployed or underemployed and he must have spent at least three years in the labor force. All applicants were graduated from high school or had a high school equivalency. Some familiarity with mechanics or machine operation and an expressed desire to become retrained as a technician were also required. The General Aptitude Test Battery was used to measure aptitudes. The three pertinent measures which were used for selection were General, Numerical and Spatial abilities. An interview was used to confirm the aspirations of each of the applications.

The final screening of applicants was completed by a research team from The Pennsylvania State University. In this final screening we went to the State Employment Service offices close to the homes of the applicants. At the time of the screening we presented a seventeen minute motion picture film entitled "Upgrade" which was used to describe the field of work of a person in tool design technology and to describe the training program. In addition we interviewed each applicant to try to determine something about his desire to complete such a training program, to determine his maturity and to estimate the realism with which he had considered the retraining. We also gathered data concerning the applicant's work history and previous education.

On the basis of aptitudes, interview evaluation, work history and previous education we formed a pool of qualified applicants for the two training programs. From this pool we assigned persons on the basis of their preference for training location. With the exception of perhaps half-a-dozen cases, we were able to assign students according to their first choice. There tended to be a geographic factor working in assigning students, inasmuch as most of them chose the training facility closest to home. Students were not randomly placed. We assigned 75 trainees, 35 to the job-oriented program and 40 to the field-oriented program from an original 109 applicants.

In most respects we were unable to measure differences between the two groups. There was no significant difference in the General Aptitude Test Battery scores. With a mean of 100 and standard deviation of twenty on the GATB, both groups were near one standard deviation above the mean on all three measures.

Approximately one-third of the students in each of the programs had completed some education beyond high school. The mean number of years of formal education were 12.4 and 12.2 years. The age of the students was about 23-1/2 years at the beginning of training. About one-third were teenagers, 18 or 19. The oldest man in the job-oriented program was 43 and the oldest in the field-oriented program was 47. Since these were retraining programs, we had expected that the mean age of the group would be somewhat higher, perhaps about thirty. But since we are currently in a period of high employment, there do not seem to be as many older men who are available for retraining. About one-third of the men were married and many of them had graduated from high school in the spring of 1964.

Curriculum

Curriculums in the two programs included approximately 1600 hours of instruction. In the field-oriented program there were 47, 37-1/2 hour weeks while in the job-oriented program there were 50, 35 hour weeks. An examination of course content indicated that in many respects the two curriculums were similar. Drafting and design composed about half of each course. There were similar amounts of mechanics, strength of materials, mathematics, and communications in each program. The job-oriented program, however, did include 246 hours of machine shop and welding while there was no similar laboratory course in the field-oriented program. Courses under production included industrial processes, engineering economics, industrial organization and management, quality control, and production problems.

Student Satisfaction with Training

Considering the amount of material presented as related to the short fifty week length, both programs were quite different from typical technician training. We were, therefore, greatly concerned about how satisfied the students were with the training received.

Questionnaires completed during and after training indicated that, for the most part, students were well satisfied with the two programs. A high percentage of the students in both groups felt that they would apply for the program again if the choice could be made over. Job-oriented students felt that the program better fit their expectations than did students in the field-oriented program. They were also more certain that they wanted to remain in tool design. However, most of the students in both programs were desirous to work toward a related job which was more technical or with more responsibility such as engineering or supervision. A greater percentage of the field-oriented students aspired in this direction.

Class hours in the field-oriented program did not suit the students as well as the class hours in the job-oriented program. This difference might be attributed to the tight room scheduling at the field-oriented training site.

Student Performance

There were eighteen dropouts among the 75 students in the two groups. In the job-oriented program there were three while in the field-oriented program there were fifteen. Of these dropouts, there were twelve because of academic failure. Of those dropped for academic reasons, ten had failed a mathematics or mathematics based course such as mechanics.

Because of what seemed to us to be the importance of mathematics in success in these two programs, we were interested in investigating the relationship between math achievement and previous mathematics education. The amount of previous math education varied among students from one semester of basic mathematics in high school to completion of differential equations in college. The lapse of time since the last math course was completed previous to this training program was from one year to twenty-six years. In the field-oriented program we found that there was a significant relationship between previous mathematics education and math achievement. Twelve of thirteen students in the lower one-third in math achievement were without a previous course in trigonometry. All students in the upper one-third of the class had completed trigonometry or higher level mathematics. In other words, whether or not the student had previously studied trigonometry seemed, in part, to determine his success in the field-oriented program.

A separate investigation was conducted to determine what might best be used to predict mathematics success. (Finch, 1968). Two biographical and eight aptitude variables were analyzed to determine their correlations with the total mathematics grade point average in each of the two training programs. Multiple regression analysis with parsimony was used to determine whether two or more combined variables could provide better prediction than one variable. The best predictor of mathematics achievement for both groups was the Number Ability Test. It was not as appropriate for prediction of success with the job-oriented group as with the field-oriented group. The general nature of the Number Ability Test seemed to correspond with the broadly based mathematics courses contained in the field-oriented program.

Another concern which we had was with factors contributing to overall academic achievement in the two training programs. What aptitudes background should an aspiring technician have in order to succeed in field or job oriented training? Variables examined included biographical data and scores on tests which were administered at the start of the program.

The best predictor of success in the field-oriented program was the Number Ability Test. Other variables which provided better prediction when combined with this test included the Mechanical Comprehension Test, The Social Class Identification Scale, and the number of years since last math courses were taken.

The spatial section of the GATB was most predictive of overall success in the job-oriented program. The Social Class Identification Scale and the Paper Form Board increased prediction of success when combined with the GATB (Spatial).

Interestingly enough, the Social Class Identification Scale related to program success in a negative manner, that is, low achievers tended to personally identify with a higher social class than high achievers in the two programs. Further investigations planned in this area may turn up some interesting information.

Since there was a great difference in the number of textbooks used in the two programs, we became interested in the perceived difficulty of homework assignments and readability of the textbooks used. (Bjorkquist and Kolker, 1966). In the job-oriented program there were five assigned textbooks while in the field-oriented program there were nineteen. The textbook readability was investigated using the Flesch Reading Ease Scale. The Flesch scale is based upon average sentence length and number of syllables per hundred words. Several samples were taken from each book and an average difficulty of each book was found. Readability of the books is reported in terms of grade level. The reading ease scale indicates an approximate reading level difficulty for each book. The books used in the field-oriented program were found to be less readable and more difficult than those used in the job-oriented program.

Job-oriented students estimated that they studied approximately one-half hour more each day and perceived that their homework assignments were more difficult than did students in the field-oriented program. It may be that assignment length was equated with difficulty of assignment.

Initial Placement

One factor commonly associated with training success is the successful placement of graduates. Of the twenty-five students who graduated from the field-oriented program, nineteen or 76 percent had accepted jobs which, by job title, seemed to be related to their training. Three students (12 percent) entered the military service and one student (4 percent) enrolled in a four-year college program. Two students (8 percent) had not accepted employment as of the completion of the training. Of the 32 job-oriented graduates, 24 or 75 percent had accepted jobs related to their training, one (3 percent) entered the military service and seven (22 percent) had not accepted jobs as of the completion of training. There were many positions open to the graduates, however, some chose to remain in their "home town" area where jobs were not plentiful. This was particularly true of those graduates who were from the coal belt region of the state. Consequently, some of those who graduated accepted compromise positions or remained unemployed.

Although many graduates reported to work immediately after training, it required an average of almost four weeks for them to begin their first job. The job-oriented graduates averaged 3.93 weeks while the field-oriented graduates averaged 3.76 weeks. The time required by industry for the screening and selection of individuals they hired for technical positions was reflected by this four week figure. Time lapse from initial job application to beginning work often was two or more weeks. Many employers were hiring for the "long haul" and wanted to be assured that the right man was selected; i.e., it might take from three to six years for an individual to become a full fledged designer.

Work Skills

We had a great deal of interest in how the graduates' work related to the training they received. During the follow-up interviews data was gathered concerning worker skills in various technical areas which were taught in the two programs.

Each graduate was asked whether or not he used each of several drafting skills. Responses to these items on the first follow-up interview indicated that graduates of the job-oriented program used more of the drafting skills. Ninety-three percent of the job-oriented and 83 percent of the field-oriented graduates used some drafting skill. It should be noted that all those using drafting skills were not employed as draftsmen or designers. Some expressed the value of drafting skills in communicating ideas with fellow workers.

The utilization of design skills was also investigated. Approximately the same percentage of job-oriented graduates (75 percent) as field-oriented graduates (72 percent) were using some design skill. Larger percentages of job-oriented graduates were designing fixtures, jigs, dies, and cutting tools. This paralleled the design phase of the job-oriented program which emphasized the designing of these types of tooling particularly jigs and fixtures. As was mentioned previously, design emphasis in the field-oriented course had been more broad. The generally lower percentages of field-oriented graduates employing individual design skills was attributed primarily to greater design specialization. Many more field-oriented graduates used only one or two design skills while several job-oriented graduates were doing three, four, or five types of designing.

Some form of mathematics was used on the job by all graduates of both programs. The training stress on trigonometry and the foundation subjects of arithmetic, algebra, and plane geometry was paralleled by mathematics of the job. Calculus was not used by any graduate and was not taught in either program.

Discussion

It appears that an intensive one year program can produce qualified technicians for industry. For the most part, students indicated satisfaction with the training received and desired to be employed on a technical level.

There are some suggestions that the two training programs were attempting to prepare technicians at two levels. Attrition rates for the two programs indicate that different standards of performance were maintained. In addition, the basic foundation building nature of courses in the field-oriented program as opposed to the applied integrated characteristic of the courses in the job-oriented program also suggests two levels of preparation. This same suggestion comes from an analysis of the textbooks used. There were more textbooks used in the field-oriented program and they were more difficult to read than those in the job-oriented program.

Student mathematics ability was strongly related to academic success in the field-oriented program while spatial ability appeared to best predict success in the job-oriented program. The Number Ability Test had the most utility in mathematics success prediction for students in both programs.

Of the 57 persons who graduated, approximately 75 percent immediately accepted jobs which were related to their training. Four persons entered the military service and one enrolled as a college student while nine persons did not obtain employment immediately.

One factor which appeared to be related to a four week average time span between training and employment was some graduates' lack of mobility. Screening and selection by employers also contributed to this time figure. The selection of technicians for employment is a more involved process than that of hiring a skilled or semi-skilled worker.

High percentages of the graduates employed in industry were using, on the job, one or more phases of the specialized training they received. This was indicated by percentages using orthographic projection, sectioning, auxiliary views, dimensioning and scale drawing. The percentages involved in designing fixtures, jigs, machines, tools, and layouts further indicated that subject matter taught in the training programs was being used on the job. The utility of the specialized mathematics instruction was indicated by percentages of graduates using algebra and trigonometry.

It cannot be concluded that all the skills useful on the job were included in the training programs. No graduate reported using calculus on the job, but perhaps he might have used it if he had been prepared to do so. The same may be said of some other skills.

QUESTIONS ADDRESSED TO MR. FINCH

From the Audience:

How does the percent of the time spent by trainees in particular curriculum areas such as drafting and math relate to actual time spent on the job in similar areas?

Mr. Finch:

In the job analyses used in follow-up we did not specifically relate job duties to subjects taught in the training programs. We used the job analysis technique developed by the U. S. Department of Labor for compiling data for the Dictionary of Occupational Titles. Using this technique, we evaluated the workers level of involvement with data, people, and things. We found that a great percentage of graduates had a high level of involvement with data which does correspond with the emphasis on working with data given in training. In terms of involvement with things, a similar case can be made. It may seem strange but the graduates had very little concept of their percentage of their time used at these skills on the job.

It is questionable if there should be a relationship between time spent in learning certain skills and time spent using that skill on the job. Some essential but infrequently used job skills may require a disproportionate amount of training time. For example, some complex mathematical abilities may be necessary for holding a job, be rather infrequently used, and require a long time to learn.

From the Audience:

How did you determine whether applicants for training had any familiarity with mechanics or machine operation?

Mr. Finch:

A number of the individuals had experience as machine operators or machinists which might be an indication of some machine knowledge. Some others had some courses in shop in high school. We did not operationally define this criterion of selection and did not actually apply it. The majority of training applicants did not have industrial experience in this area. We are examining this data to determine if it made any difference in success in training.

REFERENCES

Bjorkquist, David C. and Kolker, Brenda, "The Readability of Textbooks in Two Retraining Programs for the Preparation of Technicians," Journal of Industrial Teacher Education, September, 1966.

Finch, Curtis R., "Predicting Mathematics Achievement in Technical Training", Vocational Guidance Quarterly, March, 1968.

THE DESIGN GRADUATE AND HIS JOB

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This report concerns the on-the-job performance of the graduates of the two retraining programs described by Mr. Dunn and Mr. Elison. In the section immediately preceeding this one, Mr. Finch has aptly described student characteristics and training outcomes of the programs. In this paper, the results of on-the-job follow-ups will be discussed.

Job Title

Because of our desire to know more about the work performed by these graduates than that covered by job titles, we have analyzed the jobs of each of those employed in industry. The analysis technique used was structured by the U. S. Employment Service and used in their preparation of the 1965 Edition of the Dictionary of Occupational Titles. A key focus of this type of analysis is the determination of the level at which the job requires the employee to deal with data, people, and things. In general, a hierarchy has been established in each of these three areas in which a lower code number identifies a higher level of involvement required by the job. Thus a job of compiling data requires a higher level of involvement by the worker than does a job of computing. Each of the terms used in these hierarchies is defined in the Appendix to Volume 2 of the 1965 Edition of the DOT. The code numbers derived by use of the hierarchy constitute digits 4, 5, and 6 of the six digit DOT code number.

Analysis of the 24 job titles held by the 47 graduates contacted, shows that "Tool Designer" is the most common job title. "Draftsman" is the second most common job title, while "Junior Draftsman" is the third.

Analysis in terms of involvement with data, people, things, indicated that 87 percent of the individuals contacted were engaged in either the analyzing, compiling, or the computing of data. A decision was made by the investigators to

TABLE 1

Level of Complexity at which the Job Requires the Worker to Function

Data	People	Things
0 Synthesizing	0 Mentoring	0 Setting-Up
1 Coordinating	1 Negotiating	1 Precision Working
2.Analyzing	2 Instructing	2 Operating-Controlling
3 Compiling	3 Supervising	3 Driving-Operating
4 Computing	4 Diverting	4 Manipulating
5 Copying	5 Persuading	5 Tending
6 Comparing	6 Speaking-Signaling	6 Feeding-Offbearing
7 No Significant Relationship	7 Serving	7 Handling
8 No Significant Relationship	8 No Significant Relationship	8 No Significant Relationship

classify activity of the graduates at the drafting board as being precision working with drafting instruments. Thus, 87 percent of the graduates were classified as being engaged in "precision working with things" as indicated by level 1 under "things" in the DOT hierarchy of data, people, and things.

Analysis also revealed that 70 percent of the graduates engaged in "no significant relationship" with people, while 19 percent of the graduates were engaged in a "speaking-signaling" relationship with people. We could find no significant difference between the titles in the job-trained and field-trained graduates.

Job Description Index

As part of the personal interview with the graduates, the Job-Description Index was administered. The purpose of this index was to secure the graduates' opinions about supervision, promotions, work, pay, and people.

The graduates were asked to react to a series of statements relating to work, pay, people, promotions, and supervision. Reactions were scored by giving a +3 for an affirmative answer to a positive statement, a +3 for a negative response to a negative statement, and a +1 to any response made with a "?". A 0 was given in cases of an affirmative answer to a negative statement or a negative answer to a positive statement.

Maximum score which could be obtained on attitude toward supervision was 54. This indicates a very positive or favorable attitude toward supervision. Of the 47 subjects interviewed during the last follow-up, 37 scored between 33 and 39. Thus, 79 percent of the graduates would appear to be favorably disposed toward supervision.

Attitude toward promotions were determined on a 27 point scale. On this scale, 27 individuals scored between 19 and 27; thirteen scored between 10 and 18 and seven scored between 0 and 9.

Attitude toward work was scored on a 54 point scale. Twenty-six individuals scored between 45 and 54 on the scale. Twelve individuals scored between 35 and 44, six between 25 and 34, one between 15 and 24, one between 5 and 14, and one individual scored a 0.

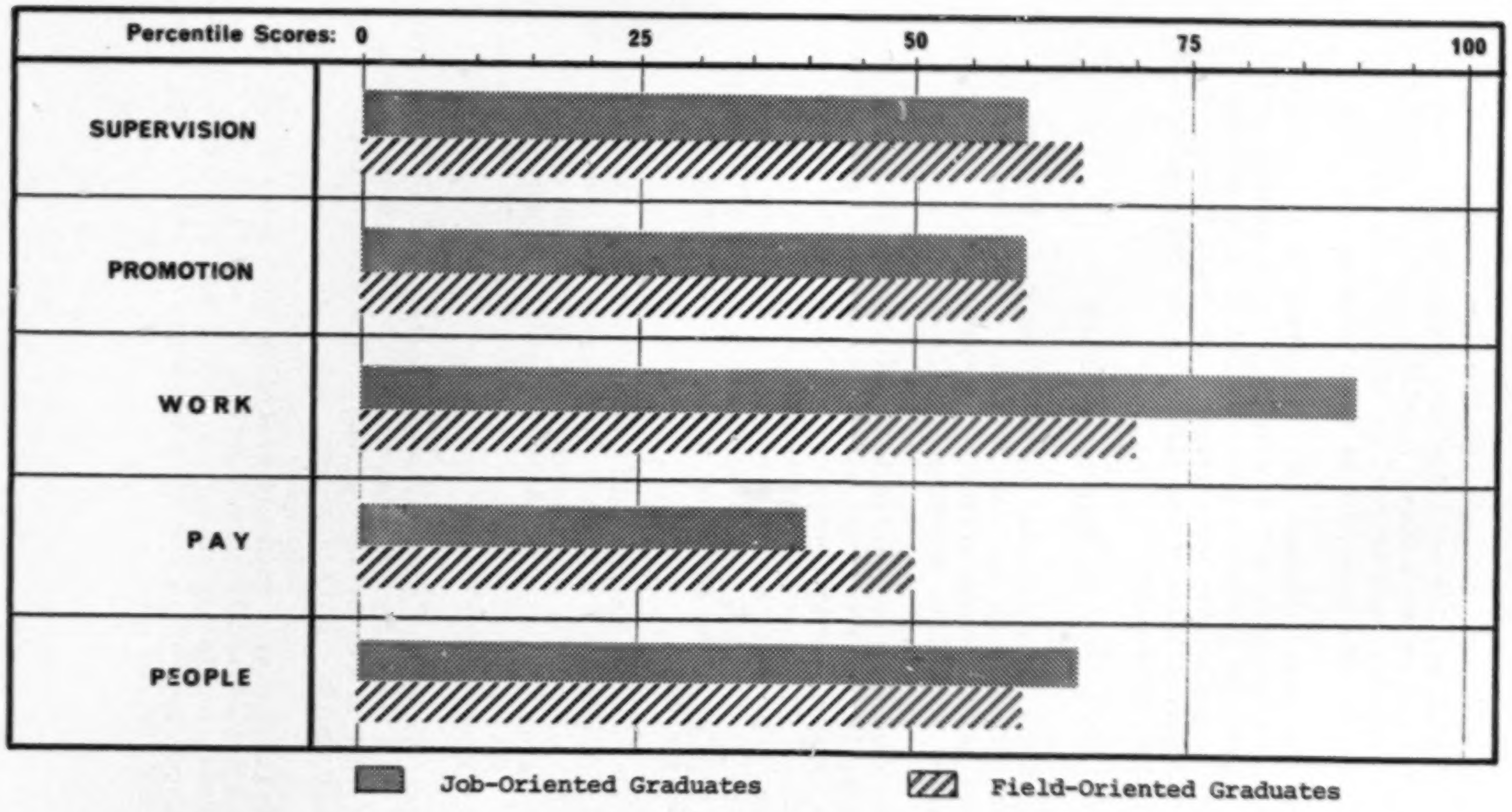

Fig.1 EMPLOYEE JOB SATISFACTION

Attitude toward people was scored on a 54 point scale. Thirty-one individuals scored between 49 and 54, nine scored between 43 and 48, three scored between 37 and 42, and 2 individuals scored between 31 and 36. One individual scored between 25 and 30, while one individual scored a 6.

Figure 1 shows a comparison of the scores of the graduates and scores on the Job-Description Index for vocational school graduates. The graph also compares the JDI Scores for the two programs. The job-oriented graduates show more satisfaction with their jobs than do the field-oriented graduates.

Employer Rating

The immediate supervisor of each graduate was asked to complete an employers rating scale. The purpose of this scale was to obtain the supervisor's evaluation of the graduate in four areas; the graduate's knowledge and understanding of his occupational technology; his quality and quantity of manipulative work; his personal and social qualities; and his work qualities. In each of the four areas there were four or five statements concerning the graduates performance in that area. The supervisors were asked to react to each statement by checking an appropriate reaction on a five point scale. These reactions were scored and averaged over the particular number of statements in that area. Thus the highest score in each area would be five.

Figure 2 shows the results of this evaluation. There was no significant difference in the evaluations of the graduates from the two programs.

First Job and Beginning Salaries

There was a significant difference in the average beginning salaries for graduates of the two training programs. Job-oriented graduates averaged $96.56 per week while field-oriented graduates averaged $110.05 per week. One possible explanation for the pay differential is the fact that field-oriented graduates were much more mobile, therefore having many more jobs from which to choose. Percentage-wise, twice as many (56 percent) who finished the field-oriented course have changed their place of residence since completion of training than have those from the job-oriented course (28 percent).

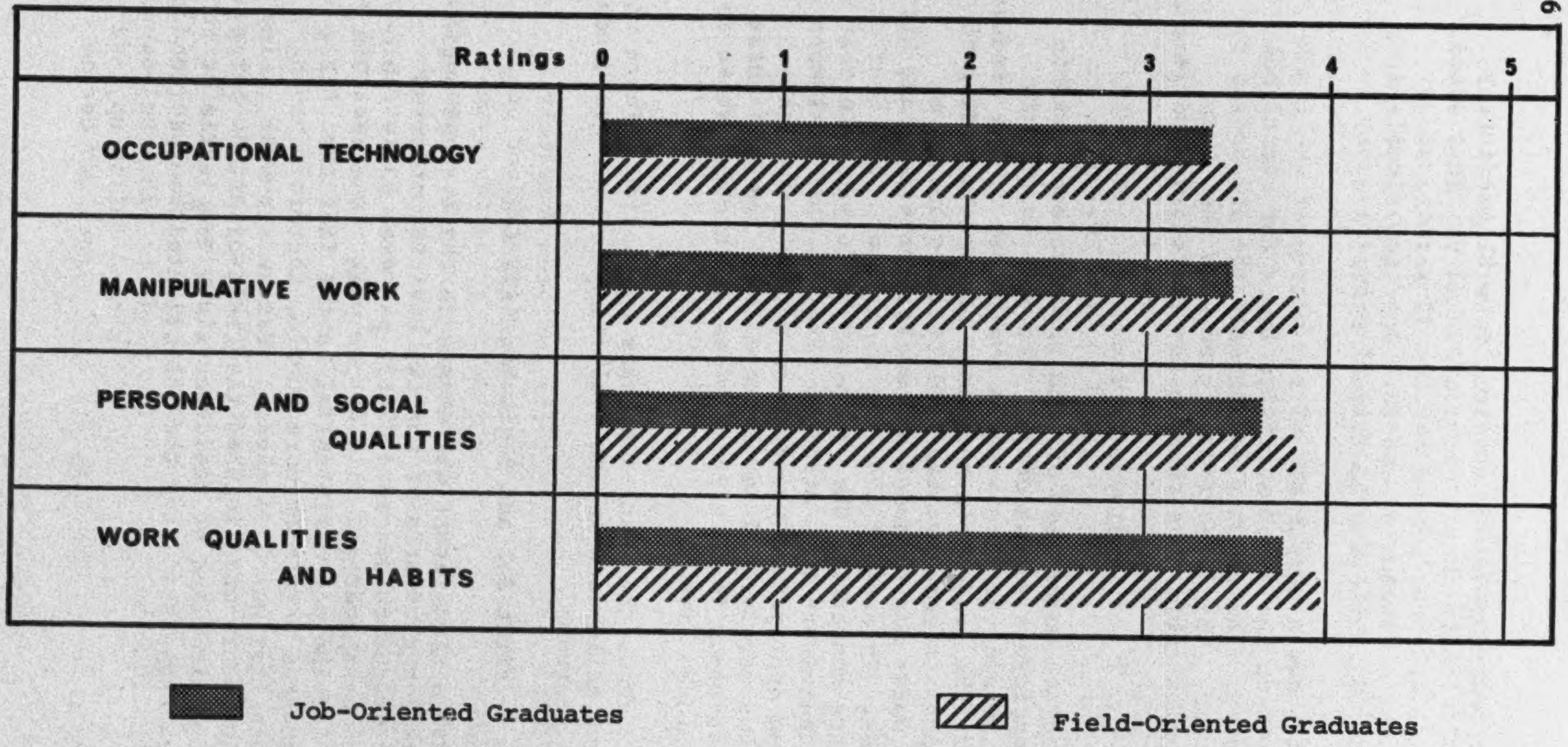

Fig. 2 EMPLOYER SATISFACTION RATINGS

Although many graduates reported to work immediately after training, it required an average of almost four weeks for them to begin their first job. The time required by industry for the selection and clearance of individuals they hire for technical positions is reflected by this four week figure. From initial job application to the time of beginning work often was two or more weeks.

Second Follow-up

The second follow-up completed one year after the completion of training revealed that 67 percent of the field-oriented graduates had received pay increases over their starting salaries. The job-oriented group showed that 64 percent had received salary increases. There was no significant difference between the two increases.

The second follow-up revealed that the majority of the field-oriented group was earning between 115-125 dollars while the majority of the job-oriented group was earning between 106-115 dollars weekly.

Results of the second follow-up indicate that in the first year after graduation thirteen percent of the job-oriented graduates had changed jobs and their place of abode. Twenty-two percent of the field-oriented group made job and residence changes. Actual number of individuals involved in changes in both cases was four.

Discussion

Critical analysis of these data has been extremely difficult to accomplish. The great need for trained people in this technical area tended to eradicate the employment differential which we hoped would become evident as employers bargained for these graduates. The evident need for technically trained individuals was probably a casual factor in the employment of individuals in similar job situations without an evident regard as to the particular type of training they had undergone.

As these individuals continued in their jobs, no striking difference between jobs, attitudes, employer satisfaction, or promotion became evident. However, we are about to conduct the third and final follow-up in the project. This follow-up follows a one year interval since the second follow-up, and since this is a longitudinal study, differences may become evident at this time.

The research staff feels that the project has served to demonstrate several important factors, however, we feel that the project does demonstrate the feasibility of the reduction of a two-year course into an intensified one-year course and that graduates of such an intensified course have proved themselves as able employees. We also feel that there is much to be said in the project about the "retraining" of the unemployed in the technical fields.

In conclusion, I would like to extend a thank you from the Research Staff of the Vocational Education Department to those companies who have employed these graduates and who have been so cooperative with the staff during the follow-ups we have conducted. We greatly appreciate the cooperation and assistance we have received during the securing of this data.

Thank you.

QUESTIONS ADDRESSED TO MR. WIERSTEINER

From the Audience:

Did graduates of the Allentown program go to work in the Allentown area primarily, and graduates of the Altoona program go to work in the Altoona area?

Mr. Wiersteiner:

Most of the graduates remained in Pennsylvania and seemed to seek employment in their home locality. Inasmuch as most of the students selected the training program closest to home, they did seek employment near their location of training.

From the Audience:

Were you able to determine whether there was a difference in the cost of living index between these two areas that might partially account for the difference in salaries?

Mr. Wiersteiner:

We did not gather any data about cost of living index or wage scales for the places where graduates were employed. These may have been factors in the salary difference between graduates of the two programs.

From the Audience:

Why wasn't there any follow-up of the people who dropped out?

Mr. Wiersteiner:

A follow-up of dropouts was completed, however, it was not as intensive as the follow-up of graduates.

From the Audience:

The two training programs started out with 75 people and ended with 47. Your degree of success is not that wonderful.

Mr. Wiersteiner:

Well no, not if you look at it in those terms, but 47 people being in industry right now does not include the other graduates fulfilling their military obligation or those now in school who may later go into industry.

From the Audience:

Starting with 75 and graduating 55 or 60 is not really great, but realistically these are 47 people who are now employed. So you are still bating 1,000 percent.

Mr. Wiersteiner:

Yes, that is the thing that I like to point to. It was demonstrated that these people could become employees of what we consider a highly technical field. These people weren't previously as much unemployed as underemployed. Evidentally these people had capacities they hadn't realized.